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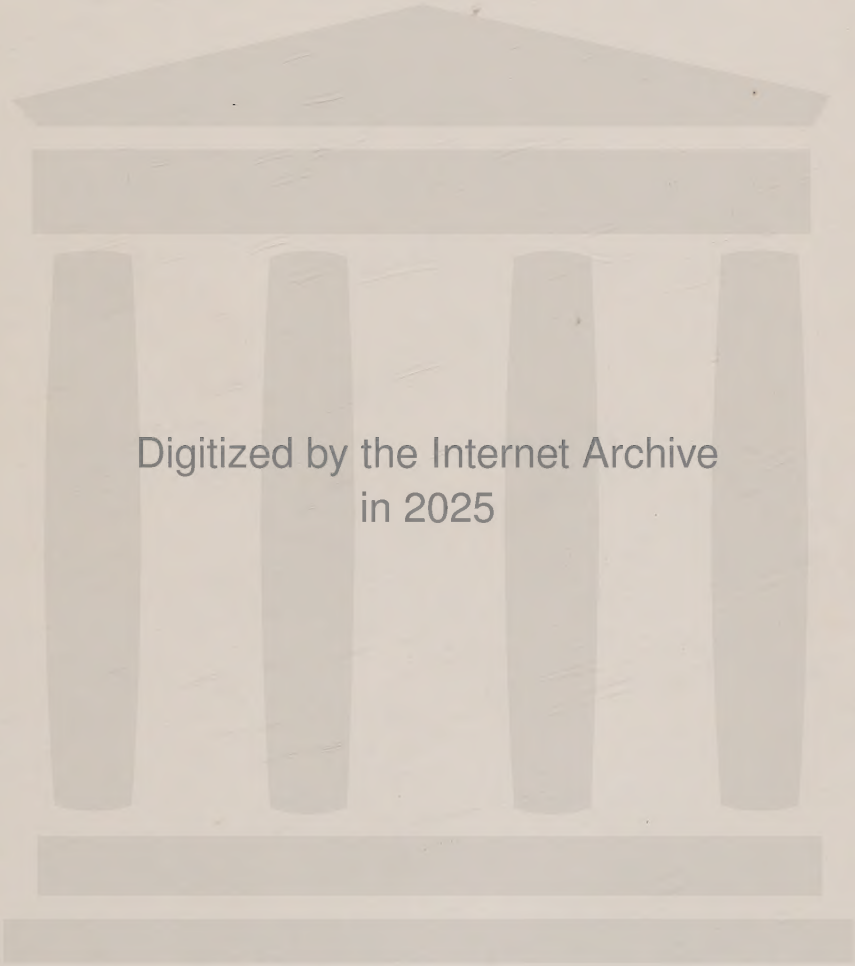
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THE MARINE DECAPOD CRUSTACEA OF CALIFORNIA

WITH SPECIAL REFERENCE TO THE DECAPOD CRUSTACEA COLLECTED BY THE UNITED STATES BUREAU OF FISHERIES STEAMER "ALBATROSS" IN CONNECTION WITH THE BIOLOGICAL SURVEY OF SAN FRANCISCO BAY DURING THE YEARS 1912-1913

BY

WALDO L. SCHMITT

UNIVERSITY OF CALIFORNIA PUBLICATIONS IN ZOOLOGY, VOL. 23

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BY

WALDO L. SCHMITT

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I. INTRODUCTION

The United States fisheries steamer "Albatross" was commissioned in October, 1911, by the Bureau of Fisheries, to make a biological survey of San Francisco Bay. The operations were directed by a board consisting of Dr. F. B. Sumner, naturalist, Professor C. A. Kofoid, of the University of California, and Commander G. H. Burrage, U.S.N., succeeded by Lieutenant-Commander H. B. Soule, U.S.N. The field work began on January 30, 1912, and continued until April 7, 1913, when the last dredge haul was made.

That portion of the results of this survey dealing with the physical conditions within San Francisco Bay has been published in a joint paper by Dr. F. B. Sumner, Dr. G. D. Louderback, Mr. W. L. Schmitt, and Mr. E. C. Johnston (1914). Discussions and detailed data are given regarding the temperature, salinity, depth of the water, and the character of the bottom for the various stations occupied by the "Albatross." These data serve as the basis for ecological studies now being made of the different groups of marine organisms obtained during the survey.

The fact that much of the literature dealing with the California decapods is to be found only in older publications, now out of print and in a large measure inaccessible to the average student, and that the more recent and very excellent works covering the region under discussion are either limited in circulation and consequently difficult to obtain or are very restricted in scope, prompted the expansion of this report upon the decapod Crustacea collected by the "Albatross" in the course of this survey of San Francisco Bay into a handbook of the marine decapod Crustacea of California.

In all 220 (+ 1, *Sergestes* sp. ?) valid species are known or reported from California waters. The vast majority belong to the so-called littoral, or continental shelf fauna; only thirty-six (+ 1 ?) are strictly deep sea, or abyssal forms, known only from depths exceeding 100 fathoms. The minimum depth from which the latter are known is indicated in all specific keys, thus distinguishing them from the forms with littoral records for which the California range limits are given. Eleven species appear to be new, not heretofore described: *Gennadas pectinatus, Palaemonetes hiltoni, Spirontocaris lagunae,*

Spirontocaris franciscana, Crago lomae, Pachycheles holosericus, Petrolisthes rathbunae, Paguristes ulreyi, Dardanus jordani, Pylopagurus holmesi, and *Homola faxoni.*

The forty-seven species taken in the course of the biological survey of San Francisco Bay are, following the systematic treatment of each, more or less fully discussed from the point of view of their distribution and habitat within the region covered by the survey. With the exception of five obtained only at shore stations, *Upogebia pugettensis, Emerita analoga, Oedignathus inermis, Petrolisthes cinctipes,* and *Pachygrapsus crassipes,* and three from miscellaneous collections, *Acantholithodes hispidus, Randallia ornata,* and *Oregonia gracilis,* these forty-seven species were taken at 133 (89%) of the 150 dredging stations, and 152 (50%) of the 305 hydrographic stations at which collecting apparatus was employed. These stations are distributed as follows:

Regions of the bay (for limitations see p. 323)	Number of stations at which collecting apparatus was employed		Number of stations at which decapods were taken	
	Dredging	Hydrographic	Dredging	Hydrographic
Upper	22	80	22	37
Middle	73	109	66	43
Lower	38	107	28	72
Outside	17	9	17	....
Total	150	305	133	152

A summarized discussion of the distribution of the bay fauna together with a few remarks on the geographical distribution of the California decapods in general concludes this paper. These remarks are confined to littoral records only, for aside from the fact that the deep sea fauna, as a rule, is more or less cosmopolitan in its distribution our knowledge of that occurring off California is too incomplete at the present time to permit of more than a mere listing, which is included in appendix I. Beside this distributional list of all the California decapods, found in appendix I, there are two other appendices, which, however, deal only with the survey data. All extensions of range recorded are based on material contained in the collections of the U. S. National Museum. After figures indicative of salinity the expression per mille ($^0/_{00}$) is to be understood.

With the exception of those designated U.S.N.M., obtained through the courtesy of the U. S. National Museum, the line drawings, both copies of figures already published as well as the several original

drawings, are the work of my wife, Alvina S. Schmitt. The photographs, from which all plates not otherwise credited were made, are the work of Mr. John Howard Paine.

Although no bibliography in the strict sense has been attempted, the literature listed includes not only works cited in the text, but also a number of useful papers collaterally consulted. In the condensed synonymy under each species, in addition to the citation of the original description, reference is made to all authors from whose works plates, figures, or extracts have been taken, and, wherever possible, to the three most recent and comprehensive works on California Crustacea, a very able paper by Weymouth (1910) on the crabs of Monterey Bay, and those landmarks, as it were, of California carcinology by Holmes (1900) and Rathbun (1904*a*).

From Weymouth I have taken many valuable color notes, several figures, and the greater part of his keys to the adult and juvenile specimens of the genus *Cancer* and the genera of the family Inachidae.

To the works of Holmes and Rathbun, however, my greatest debt of gratitude is due, for it is largely from them, as the reader will readily see, that the present paper has been compiled. The very comprehensive descriptions of Holmes have been freely drawn upon for many of the specific characterizations, as well as for the construction of several otherwise impossible keys for species I have not seen or was unable to examine. His excellent illustrations, for the greater part, have been reproduced.

In form and systematic arrangement I follow Miss Rathbun in the main, and from her monograph (1904*a*) the keys and characters for the species of *Pasiphaea, Pandalus, Spirontocaris, Crago,* and *Callianassa* have been taken practically intact. Her classificatory keys published in the *American Naturalist* (1900) were found very useful, especially in connection with the genera of the Inachidae and the Xanthidae. From her recent monograph on the *Grapsoid Crabs of America* (1918) considerable material relating to the family Pinnotheridae has been taken and a number of plates have been reproduced (plates 40 to 50 of the present paper).

Furthermore, to Miss Rathbun personally I owe much for numerous helpful and valuable suggestions, and for the use of certain of her manuscript notes, particularly those dealing with the genera *Randallia* and *Pinnixa.*

Acknowledgments are also due to Alcock, Bouvier, Borradaile, Calman, Ortmann, Smith and Weldon, from whose treatises the

classification of the higher groups of crustacea has been drawn; to Dr. Paul Bartsch, Dr. J. E. Benedict and Mr. Austin H. Clark of the U. S. National Museum; to Dr. F. B. Sumner of the Scripps Institution, naturalist of the "Albatross" during the period covered by the survey; to Dr. C. A. Kofoid of the University of California, under whose supervision this report took its inception, and Dr. S. J. Holmes of the same institution, under whose direction it has been completed, as well as to the Bureau of Fisheries and the U. S. National Museum for facilities so freely furnished in the way of study collections and literature.

The author realizes that this paper leaves much to be desired, but hopes that more thorough collecting and more intensive study will be encouraged thereby which will lead to a fuller knowledge of the Pacific Coast representatives of these interesting, and in many cases economically important forms.

Transmitted April, 1916.

II. EXPLANATION OF TERMS AND MEASUREMENTS

The Decapoda are that order of Crustacea in which the carapace fuses dorsally with all the thoracic somites and in which the three anterior pairs of thoracic appendages are turned forward to act as maxillipeds, or foot-jaws. Their gills are contained within a special branchial chamber on each side of the thorax but underneath the carapace.

The order Decapoda includes the forms commonly known as crabs, shrimps, prawns, crayfish, lobsters, and hermit crabs.

The typical decapod crustacean is divided into three major body regions, head, thorax and abdomen, the first two of which are coalesced, and are dorsally covered by a common, unjointed, cephalo-thoracic shield, the carapace. Typically there are nineteen pairs of appendages, a pair to each of the nineteen true somites into which the body is divided, grouped as follows:

I. The *Head,* composed of five indistinguishably fused somites, covered by the anterior portion of the carapace, and carrying the first five pairs of appendages:

1. The first pair of appendages are the antennules, or first antennae as they are sometimes known.
2. The second pair of appendages are the antennae.
3. The third, the mandibles, or jaws proper.

4 and 5. The fourth and fifth pairs are the first and second pairs of maxillae, or accessory jaws.

In view of their development the eyes have not been considered true appendages here. Whether they are or not is a much mooted question (cf. Calman, 1909, p. 9).

II. The *Thorax,* composed of eight somites which are dorsally fused with and also covered by the carapace, and which carry the next eight pairs of appendages:

6, 7 and 8. The first three pairs of thoracic appendages are the first, the second, and the third, or outer, external, pair of maxillipeds, foot-jaws.

9. The fourth pair of thoracic appendages is the first of the five pairs of legs from which this order of the Crustacea derives its name. The legs of this first pair are usually chelate, though they may be either subchelate or simple,

both or one only. When chelate or subchelate they are known as chelipeds. In the Brachyura, or true crabs, they are always chelate. When simple they are more properly called ambulatory legs.

10, 11, 12 and 13. The next four pairs of thoracic appendages are the second, third, fourth, and fifth pairs of legs. They may be either simple, chelate or subchelate, all or in part only. Although usually spoken of as the first, second, third and fourth pairs of ambulatory legs (except when the first legs, no. 9 above, are simple and included in the total number of ambulatory legs), strictly speaking only the simple pairs are ambulatory in the true sense of the word. In the Brachyura these four pairs of appendages are frequently designated simply as the first, second, third or fourth pairs of legs, in contradistinction to the chelipeds (no. 9, above). This nomenclature, however, has not been adopted in the characterizations of the species listed in this paper.

All mention of gills and branchial formulae has been purposely omitted as they are more or less difficult for the beginner or average student; only for the specialist have they peculiar interest.

III. The *Abdomen*, composed of six true somites, or segments, and a terminal joint, or segment, the telson, a flattened usually pointed tail-piece which never bears appendages and is not considered a true somite.

14, 15, 16, 17, and 18. The first five pairs of abdominal appendages are the pleopods, or "swimmerets," as they are sometimes called. The first one or two pairs in the males of some forms are variously modified to serve as accessory sexual organs; one or more, or all of the pleopods may be reduced, rudimentary, or wanting.

19. The last pair of abdominal appendages are the uropods and when present they constitute together with the telson the so-called "tail-fan."

The following seven diagrammatic figures give a graphic exposition of the parts, appendages, and body regions of typical decapod crustaceans:

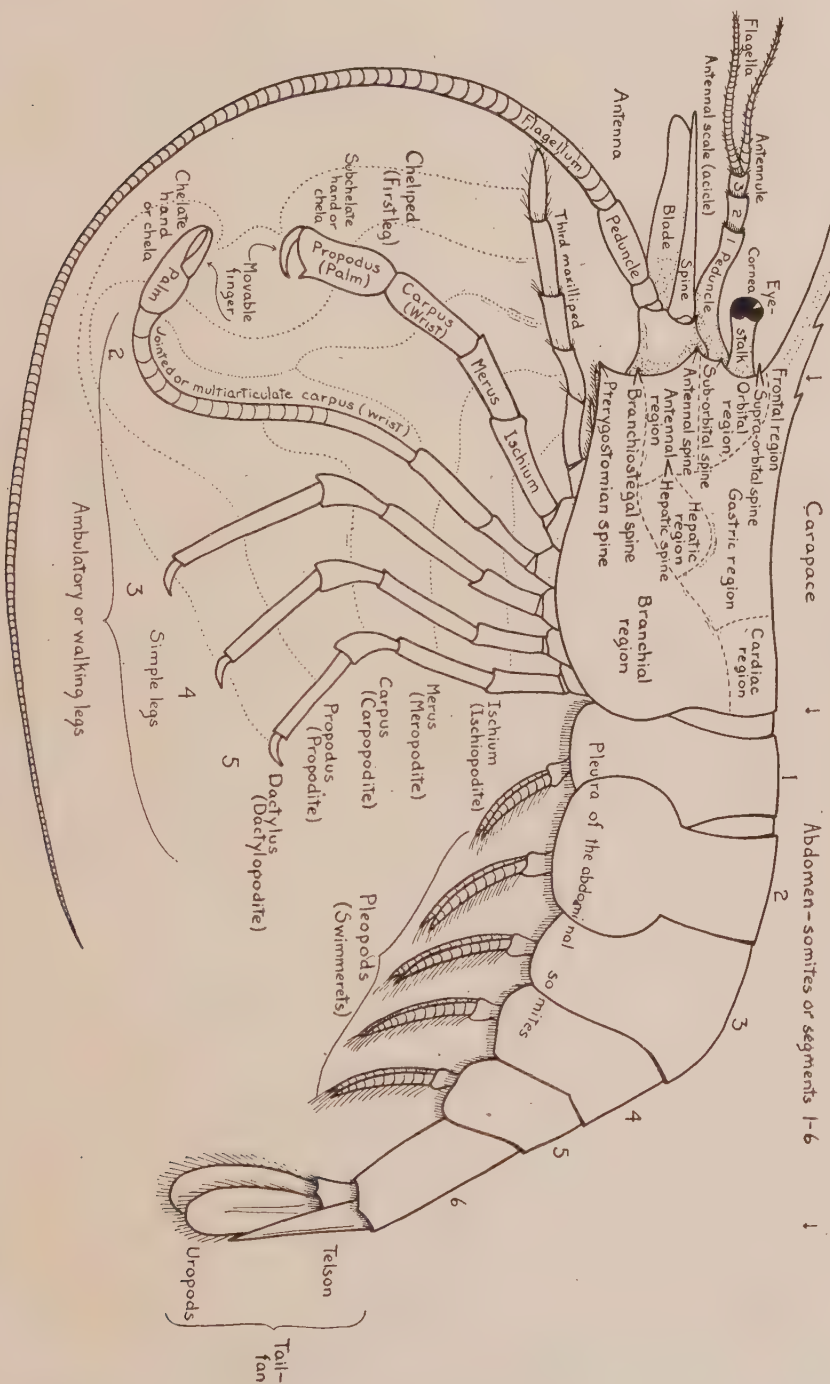


Fig. 1. Lateral view of a macruran (shrimp-like) decapod (in part after Stimpson).

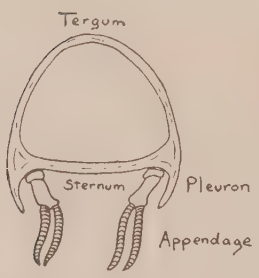


Fig. 2. Cross-section of a typical somite (adapted from Calman).

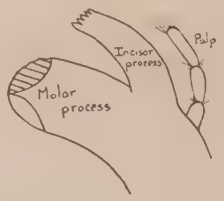


Fig. 3. Typical macruran mandible.

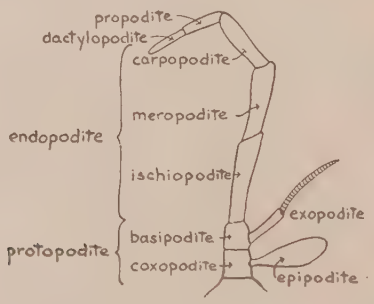


Fig. 4. Typical third maxilliped of a macruran decapod (adapted from Calman).

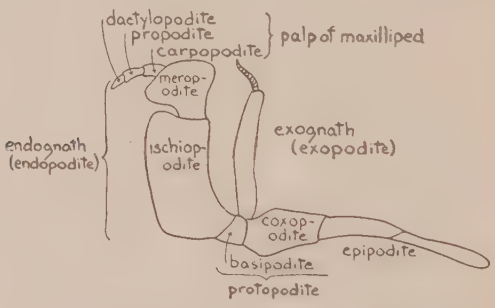


Fig. 5. Typical third maxilliped of a brachyuran (crab-like) decapod (adapted from Brooks).

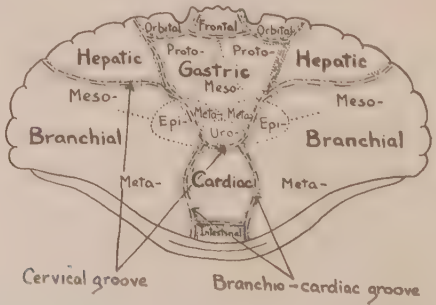


Fig. 6. Dorsal view showing regions on a brachyuran carapace (adapted from Pearson).

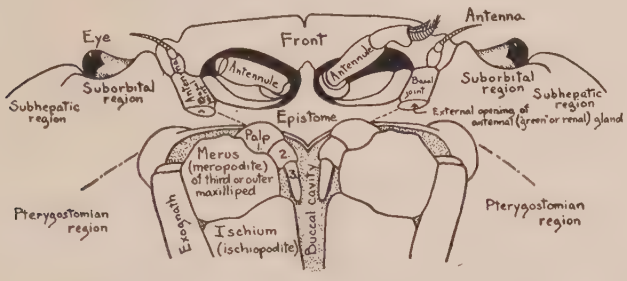


Fig. 7. Ventral view of anterior part of body of a brachyuran decapod. The roof of the buccal cavity is known as the endostome or palate.

Measurements.—Length is always measured on the median line from the anterior to the posterior margin. The length of the rostrum is measured from the line connecting, in shrimps, the posterior, and in crabs the upper margins of the orbits. "The length of segments is measured on the upper or anterior margin. The length of the whole cheliped or leg is measured on the lower margin from the articulation of the coxa with the sternum to the tip of the dactylus. The length of the immovable finger is measured from the tip to the extremity of the sinus between the fingers." (Rathbun, 1918, p. 8.)

Width of carapace, and of segments of the chelipeds and legs is measured at the widest part. "The fronto-orbital width is measured from the outer angle of one orbit to the outer angle of the other." In crabs "the width of the rostrum is measured at its posterior end." (*Op. cit.*, p. 8.)

III. SYSTEMATIC DISCUSSION OF THE CALIFORNIA REPRESENTATIVES OF THE ORDER DECAPODA

Key to the Suborders of the Decapoda

I. Body almost always laterally compressed (*macrurous,* shrimp-like). First abdominal segment not much smaller than the rest. First antennae usually having a scale at base; second antennae with scale generally large and lamellar. Legs usually slender except sometimes a stout chelate limb or pair, which may be any one of the first three pairs, with basipodite and ischiopodite never coalesced, and only one fixed point in the carpo-propodal articulation. Male genital apertures in the articular membrane between the coxopodites of the last (fifth) pair of legs, and the body; female genital apertures on the coxopodites of the third pair of legs, (except in one genus, *Leucifer,* not represented in California fauna; the sex of ovigerous females is self-evident). Pleopods always present in full number, well developed, and used for swimming.

Natantia, p. 18.

II. Body not well compressed, usually depressed (*anomurous,* hermit-crab-like, or *brachyurous,* crab-like, rarely *macrurous,* shrimp-like). First abdominal segment distinctly smaller than the rest. First antennae without a scale; second antennae, scale generally small or absent. Legs strong, first pair usually stouter than their fellows, others never so, basipodite and ischiopodite almost always coalesced in the first pair and generally in the others; two fixed points in the carpo-propodal articulation. Male genital apertures on the coxopodites of the last (fifth) pair of legs or on the sternum of the corresponding somite; female genital apertures on the coxopodites of the third pair of legs or on the sternum of the corresponding somite (the sex of ovigerous females is self-evident). Pleopods often reduced or absent, rarely used for swimming.

Reptantia, p. 104.

Suborder Natantia

Key to the Tribes of the Natantia

I. Pleura of second abdominal segment overlap those of first; abdomen generally with sharp bend. Third legs not chelate.

Caridea, p. 26.

II. Pleura of first abdominal segment not overlapped by those of second; abdomen without sharp bend. Third legs chelate.

A. Legs of third pair not stouter than those of first two pairs.

Peneidea, p. 19.

B. One or both legs of third pair longer and much stouter than those of first two pairs. (No representatives of this group found in the region covered by this paper.)

Stenopidea.

Tribe PENEIDES

Key to the California Families of the Peneides

I. Last two pairs of legs well developed.
Peneidae, p. 20.

II. Last one or two pairs of legs reduced in size, rudimentary or wanting.
Sergestidae, p. 19.

Family Sergestidae

Rostrum very small or wanting. Antennules with two flagella, one long and one short, rudimentary one which in the male is frequently furnished with a small tertiary branch. Mandibles with cutting edge smooth, and palp of two segments. First pair of legs simple, second and third pairs minutely chelate, legs increasing in length from first to third pairs; fourth and fifth pairs simple, reduced in size and number of segments.

Genus **Sergestes** Milne Edwards

Body long and slender, integument membranaceous. Rostrum very short. Antennules without a scale on inner edge; of the two antennular flagella, one is very long and the other very short, the short one in the male bifurcating to form a prehensile apparatus. Mandibular palp long, thin, and narrowly foliaceous. No exopodites on any of the thoracic appendages except the first maxillipeds.

Key to the California Species of Sergestes

I. Rostrum spiniform. Cornea larger than eye-stalk. (Known only from 145+ fathoms.)
similis, p. 19.

II. Rostrum lobiform. Cornea no larger than eye-stalk. (Known only from 417 fathoms.)
sp. indet., p. 20.

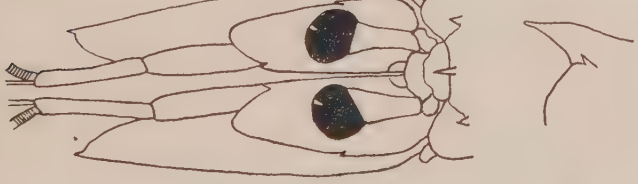
Sergestes similis Hansen

Plate 12, figure 7

Sergestes atlanticus Bate, "Challenger" Rept. Zool., **24**, Macrura, p. 389, 1888 (part: specimen from station 232).

Sergestes similis Hansen, Proc. Zool. Soc. London, p. 60, pl. 11, figs. 6*a*–6*d*, 1903.

Sergestes atlanticus Rathbun, H. A. E., **10**, 145, 1904 (part: only specimens taken by the "Albatross"), not *S. atlanticus* Milne Edwards.



a *b*

Fig. 8. *Sergestes similis*, *a*, dorsal view of anterior end, × 5; *b*, lateral view of rostrum, × 12 (after Hansen).

Characters.—Rostrum nearly oblong-triangular, with a distinct upward trend, tip acute. Anterior margin of carapace below the rostrum strongly convex and protruding; supraocular and hepatic spines well developed; gastro-hepatic groove distinct. Corneae large, broader than deep, scarcely as long as broad. First joint of antennular peduncle considerably longer than the third, outer margin as long as the same margin of the two distal joints together; second joint rather slender and scarcely longer than the slender third joint. Antennal scale moderately broad at the end, with spine projecting beyond the terminal margin. Third maxillipeds scarcely longer than the third legs. Sixth segment of abdomen twice as long as deep; about as long as, or slightly longer than fourth and fifth together.

Dimensions.—Type: length 54 mm.; of largest specimen measured by Miss Rathbun 52 mm.; average about 40 mm.

Type Locality.—Off Japan, 345 fathoms ("Challenger" station 232, lat. 35° 11′ N, long. 139° 28′ E).

Distribution.—Also taken by the "Albatross" from off Destruction Island, Washington, to the Gulf of California, northwest of Tiburon Island, 145 to 2228 fathoms. The depth for one station (4468) in Monterey Bay is recorded as 51–309–32 fathoms.

Sergestes sp. indet.

Sergestes sp. indet., Rathbun, H. A. E., 10, 146, 1904.

"A single mutilated female *Sergestes,* without maxillipeds or trunk-legs, was dredged by the 'Albatross' in 417 fathoms off San Diego, California, station 2928. It resembles *S. mollis* Smith [Rept. U. S. Commissioner Fisheries for 1882, pp. 419–421]. Body stout; length about 38 mm. The rostrum and anterior outline are as in that species. There is a minute hepatic spine. A strong ridge runs from the anterior margin at the outer edge of the eye-stalk backward to the posterior margin; the front part of the ridge is higher up than in *S. mollis;* at its middle the ridge gives off a weaker branch directed obliquely downward and backward, and then backward to the posterior margin. Gastro-cardiac groove deep; cervical groove present. Eyes a little shorter than in *S. mollis,* reaching ⅔ the length of the first antennular segment; cornea brown. Antennular peduncle rather stout, first joint the longest, 1⅔ times the second joint; second and third subequal; notch in outer side of first segment very slight. Antennal scales broken off. Abdomen as in *S. mollis.* Telson broken off. No hairs visible on outer margin of outer uropod." (Rathbun.)

Family Peneidae

Rostrum usually well developed, sometimes short and elevated, laterally compressed, often toothed. Antennules with two flagella; basal joint of peduncle dorsally concave for the eye, and strengthened at the base, on outer side, by a spine-like scale. Mandibles with incisor process, and palp of one or two segments. First three pairs of legs similar, chelate, and slender, increasing in length from before backward; remaining two pairs well developed, simple.

Key to the California Genera of the Peneidae

I. Rostrum toothed above and below. Inner border of first segment of antennular peduncle with a twisted setose scale. (Not known north of San Francisco Bay.)

Peneus, p. 21.

II. Rostrum if armed, toothed above only. Setose scale on inner border of first segment of antennular peduncle wanting or quite rudimentary.

A. Endopodites of second maxillipeds of the usual subpediform shape. (Known only from 331+ fathoms.)

Benthesicymus, p. 22.

B. Endopodites of second maxillipeds with merus thin, broad, and compressed, expanded into a thin, oval leaf-like process, or lamina, completely concealing the next three joints when flexed. (Known only from 266 + fathoms.)

Gennadas, p. 23.

Genus **Peneus** Weber

Rostrum well developed, toothed above and below. Outer edge of basal joint of antennular peduncle produced anteriorly into a spine; inner edge, proximally, with a conspicuous, twisted, setose scale; antennular flagella shorter than the carapace. Mandibular palp large and broadly foliaceous, two jointed, second joint vastly larger than the first. Exopodites on all or all but the last pair of legs.

Peneus brevirostris Kingsley

Peneus brevirostris Kingsley, Proc. Acad. Nat. Sci. Phila., 30, 98, 1878.

Penaeus californiensis Holmes, Occas. Papers Calif. Acad. Sci., 7, 218, pl. 4, figs. 64–69, 1900.

Penaeus brevirostris Rathbun, Proc. Wash. Acad. Sci., 4, 287, 1902; H. A. E., 10, 146, 1904.

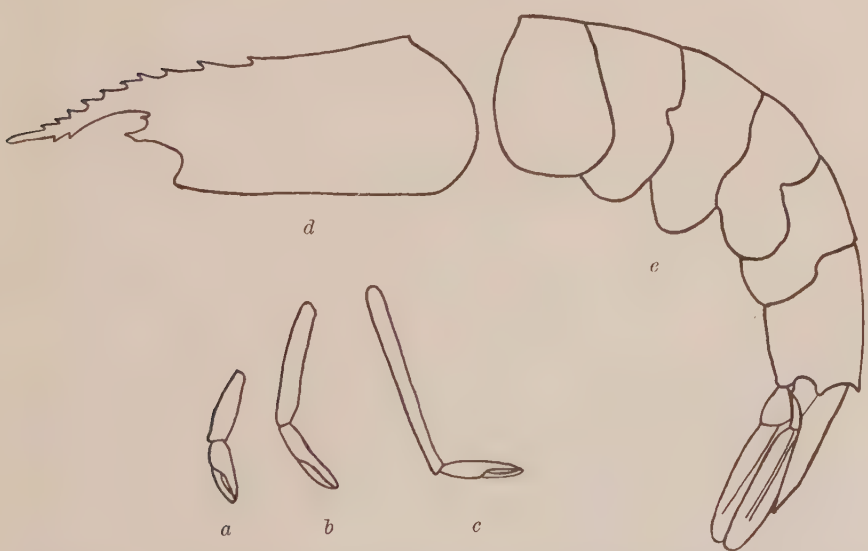


Fig. 9. *Peneus brevirostris; a*, hand and carpus of first pair of legs; *b*, hand and carpus of second pair; *c*, hand and carpus of third pair; *d*, lateral view of carapace; *e*, lateral view of abdomen (after Holmes).

Characters.—Rostrum exceeding eyes, but falling short of antennular peduncle; above ciliate and armed with nine to ten teeth, below with two small teeth near depressed tip; rostrum continued backward as a carina nearly to posterior margin of carapace and sulcate posterior to last tooth. Carapace with sulcus parallel to and on each side of dorsal carina, continued forward from posterior extremity of dorsal carina onto lateral ridges of rostrum; outer margins of sulci more prominent near last rostral tooth and distinctly flared outward. Telson acute, deeply sulcate above, and devoid of lateral spines or spinules; greatly exceeded by the uropods.

Dimensions.—Length 42 mm., carapace 10 mm., rostrum 5 mm. (Kingsley). Of specimen examined by Holmes, length from tip of rostrum to tip of telson 182 mm.; carapace, including rostrum, 41 mm.; rostrum 24 mm.

Type Locality.—Estero at Realijo, west coast Nicaragua (salt water).

Distribution.—San Francisco Bay, California to Panama; Galapagos Islands. To a depth of 51½ fathoms (Rathbun).

Genus **Benthesicymus** Bate

Rostrum short, elevated, compressed; if armed, toothed above only. Outer edge of basal joint of antennular peduncle armed with one or two spines; no scale on inner edge; antennular flagella longer than the carapace. Mandibular palp foliaceous, two-jointed, second joint narrower and shorter than the first. Exopodites of second maxillipeds much longer than endopodites; endopodites subpediform with last three joints more or less flexed on the merus. Exopodites on all the legs decreasing in size posteriorly until they become rudimentary on the last pair of legs.

Key to the California Species of Benthesicymus

I. Median carina of fifth and sixth abdominal segments terminating posteriorly in a small acute tooth.
tanneri, p. 23.

II. Fifth and sixth abdominal segments devoid of teeth; posterior margin of sixth segment raised to form a peculiar transverse ridge.
altus, p. 22.

Benthesicymus altus Bate

Plate 11, figure 2

Benthesicymus altus Bate, Ann. Mag. Nat. Hist., (5), **8**, 191, 1881; "Challenger" Rept., Zool., **24**, Macrura, p. 336, pl. 58, fig. 1, 1888; Faxon, Mem. Mus. Comp. Zool., **18**, 203, 1895.

Characters.—Rostrum short, compressed, apex styliform, crest thin and armed with two teeth, continued back as a carina as far as the cervical groove, posterior to which the dorsal surface is smooth and rounded; last three abdominal segments much compressed, the fourth but slightly carinated, more so on the posterior half than anteriorly, the sixth segment with a small but decided carina, which fades out before it reaches the transversely elevated posterior margin.

Dimensions.—Type, female: length 120 mm.

Type Locality.—Between Australia and New Guinea, 1400 fathoms ("Challenger" station 184).

Distribution.—South Pacific; Philippines; Japan; South Atlantic, off Tristan da Cunha; 500 to 1900 fathoms (Bate). Gulf of Panama; west coast of Central

America; Galapagos Islands; 1360 to 2232 fathoms (Faxon). Off San Nicolas Island, California; 1350 to 2182 fathoms (''Albatross'' station 4390).

Remarks.—In Bate's figure of this species there appears to be a small spine on the side of the carapace although none is mentioned in his description. In the ''Albatross'' specimens there is no spine at this place (Faxon).

Benthesicymus tanneri Faxon

Benthesicymus tanneri Faxon, Bull. Mus. Comp. Zool., **24**, 215, 1893; Mem. Mus. Comp. Zool., **18**, 205, pl. H, 1895; Rathbun, H. A. E., **10**, 147, 1904.

Fig. 10. *Benthesicymus tanneri*, ♂, lateral view of carapace, × 4/5 (after Faxon).

Characters.—Rostrum short, acute, laterally compressed, raised above the orbit into a crest, which is armed with two slender, acute teeth; rostral crest continued backward as a sharp keel on the median line of the carapace, as far as the cervical groove, behind which it is obsolescent. First three abdominal segments of the abdomen are thick, rounded, and devoid of dorsal carina, or tooth; the fourth faintly carinate but not toothed; the fifth and sixth distinctly carinate and armed with a small, acute posterior tooth; telson short, convex above, and armed with three pairs of lateral spinules.

Dimensions.—Type: length 112 mm.; length of carapace 44.5 mm.; of rostrum 8 mm.

Color.—When alive deep red, with a large patch of bright blue on the back of the second, third, and fourth abdominal segments; eyes black (Faxon).

Type Locality.—Gulf of California, 905 fathoms (''Albatross'' station 3436).

Distribution.—From off San Diego, California, to Ecuador; Galapagos Islands; 331 to 1322 fathoms (Rathbun).

Remarks.—This species is very similar to *B. altus*, and regarding it Faxon says: ''In this species the carina on the fifth and sixth abdominal segments terminates posteriorly in a small acute tooth, whereas in the preceding species, *B. altus*, these segments are destitute of teeth, the posterior margin of the sixth rising to form a peculiar transverse ridge.''

Genus **Gennadas** Bate

Very similar to *Benthesicymus*. Exopodites of second maxillipeds only about as long as endopodites, which have a thin, broad, expanded oval merus, beneath which the three terminal joints are concealed when flexed.

Key to the California Species of Gennadas

I. Rostrum armed with a single tooth; dorsal carina distinct nearly to posterior margin of carapace.
borealis, p. 24.

II. Rostrum armed with two slender, acute teeth; dorsal carina fading out before reaching cervical groove.
pectinatus, p. 25.

Gennadus borealis Rathbun

Gennadus borealis Rathbun, Proc. U. S. Nat. Mus., 24, 887, 1902; H. A. E., 10, 147, figs. 88 and 89, 1904.

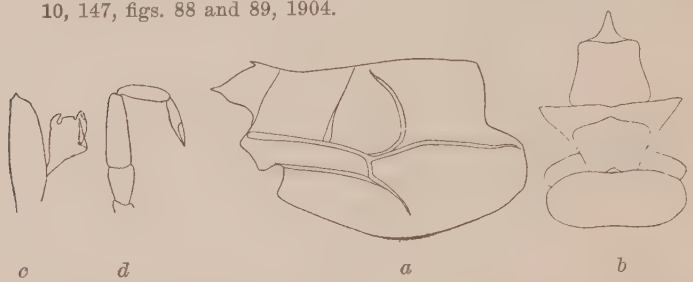


Fig. 11. *Gennadas borealis; a*, lateral view of carapace, ♀, × 2; *b*, thelycum, × 5; *c*, petasma, × 5; *d*, foot of first pair, ♂, × 3 (Rathbun, U. S. N. M.).

Characters.—Rostrum reaching at least half way along the eye-stalk, sometimes to the cornea, armed with a single tooth; carina very distinct nearly to the posterior margin of the carapace, but sharpest in front of the cervical groove; a sharp marginal spine at the angle of the antero-lateral sinus. Eyes light brown, globular, having a speck of black pigment near their base on the outer margin of the stalk; tubercle large and acute. Antennal scale extends beyond the antennular peduncle by about the length of the last segment of the peduncle. Chelae of first pair of feet narrow and elongate, as in the succeeding pairs.

Thelycum[1] consisting of a horizontal, convex, subtriangular plate, or tubercle, placed between the third pair of legs, followed by two transverse plates between the fourth and fifth pairs. The anterior of these two plates is subquadrilateral, narrowest in front; the posterior plate is somewhat fan-shaped, narrow behind, its anterior margin rounding and with a blunt median point. The andricum or petasma[2] consists of a pair of small leaves not in contact, each of which is attached at its proximal end; at extremities of distal margin are two lobes or teeth, the outer of which is curved; the inner portion is partially folded to form an irregular longitudinal plate.

Exopodites of first abdominal appendages not so long as the carapace; between the bases of these appendages is a sharp spine, equally developed in both sexes.

Sixth abdominal somite carinate, more than twice as long as fifth; telson with a small lateral spine at its posterior fourth, two spines at tip.

Dimensions.—Type, male: length of carapace and rostrum 13.6 mm., of abdomen on middle line 29 mm.; female: length of carapace and rostrum 18 mm., of abdomen on middle line 37 mm.

Type Locality.—Off Copper Island, Kamchatka, 1567 fathoms ("Albatross" station 3783).

Distribution.—Also taken by the "Albatross" from north of Rat Islands, Aleutians, to off South Coronado Island, Lower California, 266 to 2182 fathoms.

Remarks.—Very near *G. parvus* Bate, but differs in the longer rostrum, the presence of a lateral spine on the telson, the greater length of the antennal scale, the elongated chelae of the first pair of feet, and the different form of the thelycum and andricum or petasma (Rathbun).

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[1] An accessory reproductive structure on the ventral surface of the cephalothorax peculiar to the female.

[2] A membranous accessory reproductive structure attached to the first pair of pleopods of the male.

Gennadas pectinatus, sp. nov.

Plate 11, figure 1

Fig. 12. *Gennadas pectinatus;* thelycum.

Description.—Rostrum slightly ascending, with a styliform apex, and armed above with two slender teeth, of which the posterior is situated just above the posterior margin of the orbit and the anterior just behind the middle of the rostrum; the rostrum exceeds the eyes by one-half the length of that portion lying anterior to the anterior dorsal spine; dorsal carina continued backward as far as the cervical groove, behind which the dorsal surface of the carapace is smooth and rounded; at the antero-lateral sinus is a sharp marginal spine. Eyes apparently devoid of pigment; tubercle on inner angle of somewhat flattened eyestalk, small and blunt. Spine of antennal scale falls short of the extremity of the blade by nearly the width of the blade at the end of the spine; antennular peduncle reaching a little beyond middle of antennal scale. Endopodites of external or third maxillipeds broken off. Palm and fingers of first pair of chelipeds subequal in length; of the second pair the palm is about four-fifths the length of the fingers.

Thelycum as figured (fig. 12), a hastate, medially carinated plate between the bases of the fourth pair of legs, a curved spine between the third pair, and a more or less rectangular pubescent area between the last pair of legs.

Exopodites of first abdominal appendages as long as distance from tip of rostrum to posterior margin of first abdominal segment, including carapace; between the bases of these appendages there is a thickened triangular plate with a blunt, forwardly-directed apex. Fifth and sixth abdominal segments carinated, carina of fifth ending in a small, sharp spine, which projects beyond the posterior margin of the segment. Sixth segment more than twice as long as the fifth, with posterior end partly broken away; it may have ended in a spine like the fifth. There is a small spine at the postero-ventral angle of the sixth segment, and a large one at the postero-dorsal angle of the epimeron of the fifth. Fourth abdominal segment armed on the posterior margin with a peculiar comb-like structure, a series of pectinations beginning with a few denticles just above the epimeron, which increase in size and become spine-like toward the median line, forming there quite conspicuous teeth which in the type specimen are as much as one and one-half millimeters long. Outer blade of uropods exceeding the inner by about one-third of their length; telson with four pairs of lateral spines, tip broken.

Dimensions.—Type, female: length of carapace and rostrum 41 mm., of abdomen to extremity of broken telson 74 mm.

Type Locality.—Known only from a single female specimen (Cat. No. 53329, U.S.N.M.), dredged by the "Albatross" in 1350 to 2182 fathoms, off Santa Catalina Island, California (station 4390).

Remarks.—This species differs, so far as I am aware, from all known species of *Gennadas* in the peculiar armature of the posterior margin of the fourth abdominal segment.

Tribe CARIDES

Key to the California Families of the Carides

I. Exopodites on all legs; first two pairs chelate; second wrists undivided.

A. Exopodites of second maxillipeds rudimentary or wanting. Rostrum short or wanting, often represented by a postfrontal tooth or spine.

Pasiphaeidae, p. 27.

B. Exopodites of second maxillipeds large. Rostrum moderately or well developed.

Oplophoridae, p. 32.

II. No exopodites on legs.

A. One or both legs of first pair simple; legs of second pair unequal, second wrists subdivided (multiarticulate).

1. Only one leg of first pair simple, the other chelate. Rostrum not toothed except at apex, which is obscurely bifid. (Not known north of San Diego.)

Lysmatidae, p. 80.

2. Both legs of first pair simple; first two pairs slender. Rostrum large and toothed.

Pandalidae, p. 40.

B. Both legs of first pair chelate or subchelate.

1. First pair of legs subchelate; second wrists undivided. Rostrum small, or wanting; occasionally a somewhat elongate suberect spine.

Cragonidae, p. 81.

2. First pair of legs chelate; second wrists either subdivided or undivided.

a. Second wrists undivided.

i. First antennae with two flagella, one usually cleft a little distance from the tip. (Not known north of Santa Cruz Island.)

Pontoniidae, p. 37.

ii. First antennae with three flagella, owing to cleavage of one almost, or quite to the base. (Not known north of San Pedro.)

Palaemonidae, p. 34.

b. Second wrists subdivided (multiarticulate).

i. Eyes covered by carapace. First legs much stronger than the rest; second wrists divided into five segments. Rostrum small or wanting.

Crangonidae, p. 73.

ii. Eyes not covered by carapace, free. First legs not much stronger than the rest; second wrists divided into three, seven, or many segments. Rostrum generally prominent.

a. Second pair of legs equal or subequal; wrists divided into three, seven, or about thirty-two segments. Rostrum toothed; rarely reduced in size.

Hippolytidae, p. 47.

b. Second pair of legs unequal, wrist of longer leg about twice length of shorter one, wrists multiarticulate. Rostrum not toothed, except at apex, which is obscurely bifid. (Not known north of San Diego.)

Lysmatidae, p. 80.

Family Pasiphaeidae

Rostrum short or wanting, often represented by a postfrontal (gastric) tooth or spine. Mandibles lacking molar process, consisting of incisor process alone, with or without palp of one or two segments. Exopodites present on all thoracic legs and on third or external maxillipeds, rudimentary or wanting on second maxillipeds but often constituting the chief part of the first maxillipeds. First two pairs of legs similar, ending in elongate chelae with long, slender fingers, and stouter than the remaining three pairs, which are undersized and imperfectly formed.

Key to the California Genera of the Pasiphaeidae

I. Rostrum wanting, represented by a postfrontal (gastric) tooth or spine.

Pasiphaea, p. 27.

II. A short, normally formed rostrum present.

Parapasiphae, p. 31.

Genus **Pasiphaea** Savigny

Body strongly compressed. Rostrum wanting, represented by a postfrontal gastric spine or tooth. Frontal margin of carapace with orbits but slightly excavate and imperfectly defined. Mandibles without a palp.

Key to the California Species of Pasiphaea

I. Carapace carinated throughout its length.

A. Telson truncate, not forked or notched. (Known only from 250 + fathoms.)

magna, p. 28.

B. Telson forked or notched.

1. Branchiostegal spine over the angle of the anterolateral sinus.

pacifica, p. 29.

2. Branchiostegal spine farther forward, near or on anterior margin.

a. Telson longer than sixth segment. (Known only from 250 + fathoms.)

emarginata, p. 30.

b. Telson shorter than sixth segment. (Known only from 750 + fathoms.)

corteziana, p. 30.

II. Carapace not carinated in its posterior half. (Known only from 950 + fathoms.)

affinis, p. 31.

Pasiphaea magna Faxon?

Pasiphaea magna Faxon, Bull. Mus. Comp. Zool., 24, 209, 1893; Mem. Mus. Comp. Zool., 18, 176, pl. 45, figs. 2–2*c*, 1895.
Pasiphaea magna? Rathbun, H. A. E., 10, 19, fig. 1, 1904.

a *b*

Fig. 13. *Pasiphaea magna, a,* lateral view of carapace, × ⅘ (after Faxon); *b*, telson, × 1⅓ (from Rathbun, U. S. N. M.).

Miss Rathbun had a number of specimens from California which she doubtfully referred to this species. Regarding them, she said (1904, p. 19):

"The identification of these specimens with *P. magna* is doubtful, but as I have not had the opportunity of comparing them with the type, they are placed here provisionally. Though from the same depth of water, the integument is much firmer in our examples than in the type, the carapace is deeper and its dorsal outline less arched, the branchial ridge is straighter throughout the posterior half of its course, the palm of the first pair of chelae is longer than the fingers.

The largest specimen, an ovigerous female... is 155 mm. long. The telson is a little longer than the sixth segment of the abdomen, and reaches about to the end of the inner uropod; it is broadly channeled, extremity truncate or slightly convex, and armed with about 13 slender bristles.... In the first pair of legs the palm is about one-third longer than the fingers; in the second pair the right merus has 14 spines, the left 13.

Characters.—Of *Pasiphaea magna,* taken from Faxon: Carapace a little less than two-fifths of the length of the whole body; laterally compressed, dorsally carinate; carina rounded, except on anterior part of gastric area, where it assumes the form of a sharp keel, and is continuous with the acute-tipped, blade-like tooth which simulates a true rostrum; this tooth reaches forward nearly to the anterior extremity of the eyes; its lower margin is convex, with its hinder part resting closely upon and apparently anchylosed with the frontal region of the carapace. Palm of first pair of legs somewhat shorter than the dactylus; merus armed with four or five spines on its inferior edge. Second pair of legs a little longer than the first pair, with a longer and more slender chela. The second segment (basipodite) is armed with a small spine at the distal end of the inferior edge; inferior edge of merus armed with thirteen spines; carpus armed with one long spine at distal end of lower margin. All abdominal segments dorsally carinated; carina obsolescent on first segment.

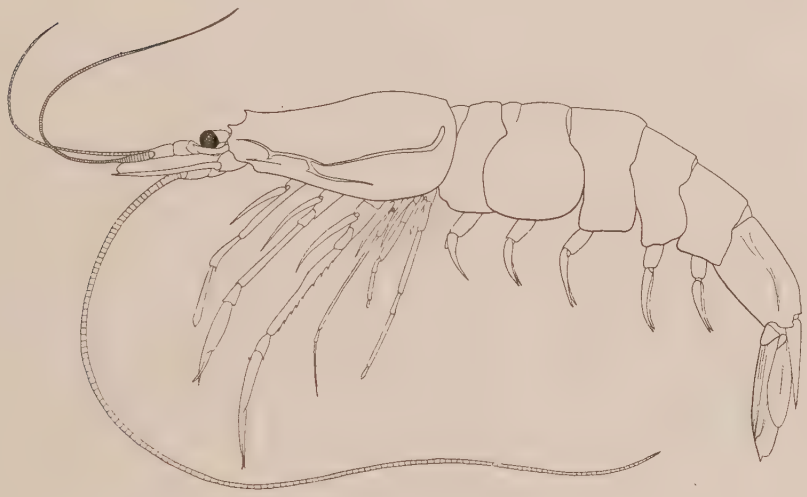
Dimensions.—Type of *P. magna:* length 145 mm.; carapace, including anterior dorsal tooth, 55 mm.

Type Locality.—Gulf of Panama, 458 fathoms ("Albatross" station 3384).

Distribution.—Also taken by the "Albatross" from off Point Arena to off Point Loma, California, 276 to 552 fathoms.

Pasiphaea pacifica Rathbun

Pasiphaea pacifica Rathbun, Proc. U. S. Nat. Mus., 24, 905, 1902; H. A. E., 10, 20, fig. 2, 1904.



a

b

Fig. 14. *Pasiphaea pacifica;* ♀, *a*, lateral view, × 1⅓; *b*, telson, × 3⅓ (from Rathbun, U. S. N. M.).

Characters.—Carapace a little less than half the length of the abdomen. Gastric tooth variable, more or less inclined upward, terminally usually slender, anterior margin concave; continued back as a thin, sharp keel, which becomes a rounded ridge behind the gastric region. Branchiostegal spine situated over the angle of the anterolateral sinus. Second to sixth abdominal segments, inclusive, carinate. Telson four-fifths as long as sixth somite of abdomen; dorsal surface channeled; extremity with a deep notch.

Dimensions.—Type, female: length 64.8 mm.; length of carapace 20.3 mm.

Type Locality.—Off Point Sur, California, 328 fathoms (''Albatross'' station 3186).

Distribution.—From Unalaska and the Gulf of Alaska, to the Gulf of California, in 53 to 799 fathoms. Most frequent between 200 and 300 fathoms off the California coast. ''One specimen from 13 fathoms, if label be correct'' (Rathbun).

Remarks.—Differs from other species with carinated carapace in having the branchiostegal spine situated above the anterolateral sinus (Rathbun).

Pasiphaea emarginata Rathbun

Pasiphaea emarginata Rathbun, Proc. U. S. Nat. Mus., 24, 905, 1902; H. A. E., 10, 22, fig. 4, 1904.

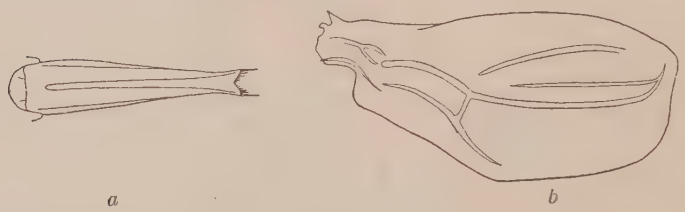


Fig. 15. *Pasiphaea emarginata;* ♀, *a,* telson, × 3⅓; *b,* lateral view of carapace, × 1⅓ (from Rathbun, U. S. N. M.).

Characters.—Carapace equal to the first five segments and half of the sixth segment of the abdomen. Gastric tooth spiniform, continued back in a blunt carina nearly to the posterior margin. First to fifth segments of abdomen slightly carinated, sixth compressed above but scarcely carinate; telson longer than the sixth segment of the abdomen, extremity with a very shallow ∨-shaped notch.

Dimensions.—Type, female: length 81 mm.; length of carapace 33.3 mm.

Type Locality.—Gulf of California, off Concepcion Bay, 857 fathoms ("Albatross" station 3009).

Distribution.—Also from off the Santa Barbara Islands and Santa Barbara Channel to off San Diego, California, 216 to 680 fathoms.

Pasiphaea corteziana Rathbun

Pasiphaea corteziana Rathbun, Proc. U. S. Nat. Mus., 24, 905, 1902; H. A. E., 10, 24, fig. 5, 1904.

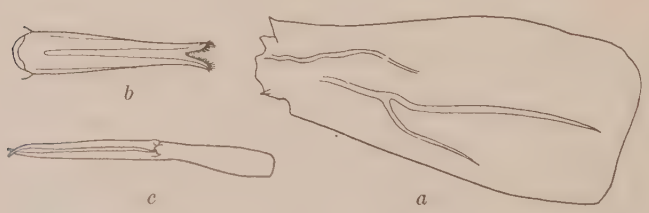


Fig. 16. *Pasiphaea corteziana,* ♂; *a,* lateral view of carapace, × 2; *b,* telson, × 2⅔; *c,* hand of second pair, × 2⅔ (from Rathbun, U. S. N. M.).

Characters.—Carapace equal to the first five and part of the sixth segment of the abdomen. Gastric tooth dentiform, continued back in a very blunt carina. Branchiostegal spine small, inserted near the anterolateral angle of the carapace just behind the anterior margin. Abdominal segments not carinate. Telson very nearly as long as the sixth abdominal segment; forked, with a deep notch.

Dimensions.—Type, male: length 64 mm.; length of carapace 23.8 mm.

Type Locality.—Near Cortez Bank, California, 776 fathoms ("Albatross" station 3627).

Distribution.—Also taken by the "Albatross" off Point San Pedro, Santa Cruz Island, California, in 764 to 891 fathoms (station 4428).

Pasiphaea affinis Rathbun

Pasiphaea affinis Rathbun, Proc. U. S. Nat. Mus., 24, 905, 1902; H. A. E., 10, 24, fig. 6, 1904.

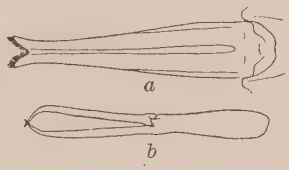


Fig. 17. *Pasiphaea affinis*, ♂, *a*, telson, × 3⅓; *b*, hand of second pair, × 2 (from Rathbun, U. S. N. M.).

Characters.—Carapace equal to the first four and half of the fifth segment of the abdomen; not carinated behind gastric tooth; otherwise much as in *P. corteziana*. Second to sixth abdominal segments, inclusive, carinate. Telson very nearly as long as the sixth abdominal segment; extremity less deeply notched than in *P. corteziana*.

Dimensions.—Type, male: length 67 mm.; length of carapace 22 mm.

Type Locality.—Near Cortez Bank, California, 984 fathoms ("Albatross" station 2919).

Genus **Parapasiphae** Smith

Body moderately compressed. Rostrum present, short, normally formed. Mandibles with slender, two-jointed palp.

Parapasiphae serrata Rathbun

Parapasiphae serrata Rathbun, Proc. U. S. Nat. Mus., 24, 904, 1902; H. A. E., 10, 25, fig. 7, 1904.

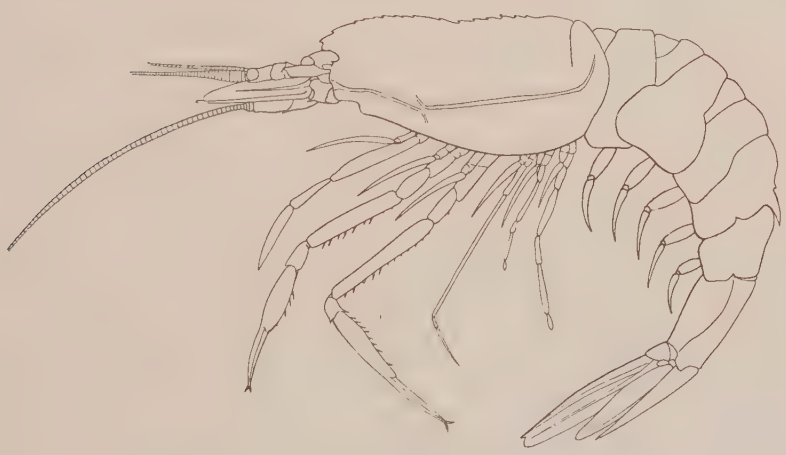


Fig. 18. *Parapasiphae serrata*, ♀, × about 1⅓ (from Rathbun, U. S. N. M.).

Characters.—Carapace and rostrum as long as the first five abdominal segments. The median carina extends backward to the posterior fifth of the carapace, or the cervical groove, and forward along the high, thin rostrum, which reaches half way along the eye-stalks; carina is armed with sixteen small teeth or spines, two of which are on the rostrum and one terminal; below this spine the rostrum is a compressed, finely crenulate lobe. Antennular scale as long as basal joint of peduncle. Antennal scale nearly half as long as carapace proper. First three abdominal segments not carinate; fourth segment posteriorly produced in a thin, compressed spine, which is carinate and has a slight notch at its base, visible in profile; sixth with a longitudinal groove on either side. Telson a little longer than sixth abdominal segment; extremity truncate.

Dimensions.—Type, ovigerous female: length of carapace and rostrum 23.6 mm.; rostrum 1.8 mm.; abdomen 42 mm.

Type Locality.—Off Cortez Bank, California, 984 fathoms ("Albatross" station 2919).

Remarks.—This species is akin to *P. gilesii* Wood-Mason, from the Indian Ocean, which also has a serrated carina running the whole length of the carapace, but the character of the rostrum alone separates it distinctly from that species. In *P. gilesii* the rostrum is a fine, acute, incurved spine, extending about a third its length beyond the eyes (Rathbun).

Family Oplophoridae (Hoplophoridae)

Rostrum moderately or well developed. Mandible with a stout, three-jointed palp, and with incisor and molar process distinct but almost confluent; molar process small. All eight pairs of thoracic appendages with well developed exopodites. First two pairs of legs ending in small but well formed chelae; last three pairs of moderate length and subequal.

Key to the California Genera of the Oplophoridae

I. Rostrum armed with teeth above and below. Second to sixth abdominal somites, inclusive, sharply carinate. (Known only from 485 + fathoms.)
Acanthephyra, p. 32.

II. Rostrum toothed above only. Abdomen devoid of a median carina. (Known only from 322 + fathoms.)
Hymenodora, p. 33.

Genus **Acanthephyra** Milne Edwards

Body compressed. Rostrum rarely short, usually long; armed with teeth above and below. Endopodite of first maxillipeds composed of three segments; the two inner distal lobes of the second maxilla narrow and projecting beyond the basal lobe. Abdomen more or less carinate; carinae of some segments ending posteriorly in a tooth or spine. Eggs, so far as known, small and numerous.

Acanthephyra curtirostris Wood-Mason

Acanthephyra curtirostris Wood-Mason, Ann. Mag. Nat. Hist. (6), **7**, 195, 1891; **9**, 364, fig. 5, 1892; Illus. Zool. "Investigator," Crustacea, pl. 3, fig. 4, 1892; Faxon, Mem. Mus. Comp. Zool., **18**, 164, pl. 43, figs. 2–5, 1895; Rathbun, H. A. E., **10**, 27, 1904.

Fig. 19. *Acanthephyra curtirostris*, ♂, lateral view of carapace (after Faxon).

Characters.—Carapace and rostrum less than half as long as the abdomen; carapace not distinctly carinated behind the gastric region. Rostrum a very thin, high, obliquely ascendant frontal crest, the acuminate peak of which does not exceed the antennular peduncle; armed above with seven to nine teeth, and below with one or, more rarely, two spines at or before the middle of the ventral border; occasionally the ventral tooth is obsolescent or but obscurely indicated. Second to sixth abdominal segments, inclusive, sharply carinate; each carina ends in a small tooth, that on the third segment being the larger, while that on the second and frequently also that on the sixth is scarcely defined; sixth segment more than half again as long as the fifth.

Dimensions.—Type, male: length from tip of rostrum to end of telson 85 mm.

Color.—In life crimson (Alcock).

Type Locality.—Bay of Bengal, 840 fathoms ("Investigator" station 100).

Distribution.—Arabian Sea, 937 to 1043 fathoms; Bay of Bengal, 364 to 913 fathoms; Andaman Sea, 922 fathoms (Alcock). From off San Clemente Island, California, to off Gulf of Panama, 485 to 2232 fathoms.

Genus **Hymenodora** Sars

Body almost round, not compressed; carapace only compressed in dorsal part, forming a sharp, high, median keel. Rostrum usually short, rarely long, armed with teeth above only. Endopodite of first maxillipeds composed of only two segments; the two inner distal lobes of the second maxilla rather broad and not projecting beyond the basal lobe. Abdomen not carinate. Eggs usually of considerable size.

Hymenodora frontalis Rathbun

Hymenodora frontalis Rathbun, Proc. U. S. Nat. Mus., 24, 904, 1902; H. A. E., 10, 28, 1904.

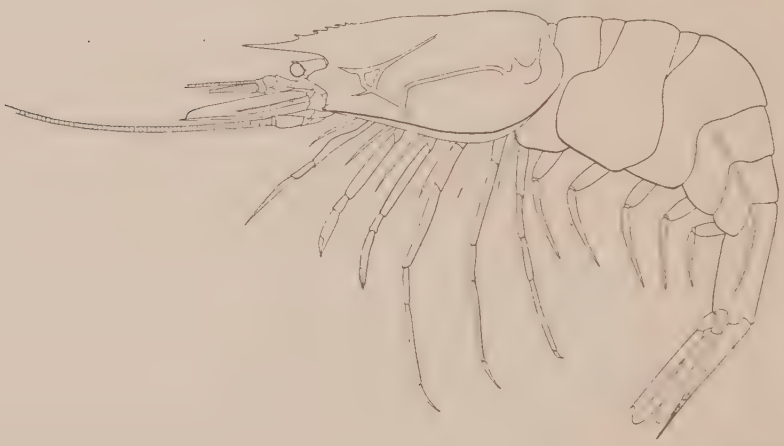


Fig. 20. *Hymenodora frontalis*, ♀, × about 2 (from Rathbun, U. S. N. M.).

Characters.—Surface covered with very fine wrinkles or rugose lines. Carapace and rostrum more than half as long as abdomen; median carina advanced in a rostrum which is unusually long for the genus, being from two-fifths to one-half as long as the remainder of the carapace and reaching the end or a little beyond the end of antennular peduncle. Rostrum a slender, sharp-pointed spine, distal half slightly curved upward, basal half armed above with three to six spines, two or three of which are beyond the line of the orbit. Abdomen devoid of a median carina or median spines; sixth segment two and a half times as long as fifth, and between three-fourths and four-fifths as long as telson.

Dimensions.—Type, male: length of carapace and rostrum 19 mm.; of rostrum 6.5 mm.; of abdomen 32.5 mm.

Type Locality.—West of Unalaska, 322 fathoms ("Albatross" station 3327).

Distribution.—From Bering Sea to off San Clemente Island, California, and Kamchatka; 322 to 1771 fathoms.

Remarks.—The unusually long rostrum distinguishes this from other species of *Hymenodora* (Rathbun).

Family Palaemonidae

Rostrum well developed, laterally compressed, and armed with teeth. Antennules with three flagella, owing to cleavage of one almost or quite to the base. Mandibles with incisor process, and with or without palp of three segments. First pair of legs chelate and shorter than second. Second pair equal and chelate, with segmented carpus, chelae generally larger than in first pair.

KEY TO THE CALIFORNIA GENERA OF THE PALAEMONIDAE

I. Rostrum prominently toothed above only, about two-thirds as long as carapace, pronouncedly convex above, armed with five to seven teeth, with one or two small teeth below near tip; behind rostrum there is a median gastric spine. An hepatic spine present. Mandible without palp. (Not known north of San Diego Bay.)

Urocaris, p. 37.

II. Rostrum prominently toothed above and below. No hepatic spine.

A. Rostrum about as long as carapace, armed with six to ten teeth above, one or two of which are behind the orbit, and with two to four teeth below. Mandible without palp. (Known only from San Pedro.)

Palaemonetes, p. 36.

B. Rostrum longer than carapace; armed with seven to eight teeth above, one or two of which are behind the orbit, and with three teeth below. Mandible with palp. (Not known north of San Diego.)

Palaemon, p. 35.

Genus **Palaemon** Fabricius

Rostrum prominently toothed above and below. Carapace furnished with antennal and branchiostegal spines, but without hepatic spine. Mandible with three-jointed palp.

Palaemon ritteri Holmes

Palaemon ritteri Holmes, Proc. Calif. Acad. Sci. (2), 4, 579, pl. 21, figs. 29–35, 1895; Occas. Papers Calif. Acad. Sci., 7, 216, 1900; Rathbun, H. A. E., 10, 29, 1904.

a *b*

Fig. 21. *Palaemon ritteri; a*, lateral view of carapace; *b*, mandible (after Holmes).

Characters.—Rostrum longer than carapace, and tapering more or less evenly from the widest portion (which is about one-fourth as wide as the rostrum is long) to an acute tip; armed above with seven to eight teeth, one or two of which are behind the orbit; below with three teeth. Ocular peduncles short and stout; the ocellus lies between the cornea and the stalk. Antennal scale is shorter than the rostrum, with blade exceeding the spine.

Dimensions.—Type: length 45 mm.

Type Locality.—San Diego, California.

Distribution.—From San Diego, California, to Gulf of California (Rathbun). Bay of St. Elena, Ecuador (Nobili).

Genus **Palaemonetes** Heller

Rostrum prominently toothed above and below. Carapace furnished with antennal and branchiostegal spine, but without hepatic spine. Mandible without palp.

Palaemonetes hiltoni sp. nov.

Plate 12, figure 5

Description.—Closely allied to *P. kadiakensis* Rathbun (1902, p. 903; 1904*a*, p. 30, fig. 9), from Alaska, and intermediate between it and *P. vulgaris* Say (1818, p. 248), of the Atlantic.

It differs from both *P. kadiakensis* and *P. vulgaris* in the proportional length of the propodal and carpal joints of the first two pairs of legs and in the relative length of the sixth abdominal segment as compared to the fifth. The following table will suffice to show these differences in the three species mentioned above:

	Palaemonetes kadiakensis	*P. hiltoni*	*P. vulgaris*
First pair of legs, propodus : carpus	1 : 2.20	1 : 1.75	1 : 1.50
Second pair of legs, propodus : carpus	1 : 2.00	1 : 1.00	1 : 0.60
merus : carpus	1 : 1.50	1 : 1.00	1 : 0.88
Abdomen, fifth segment : sixth	1 : 2.00	1 : 1.66	1 : 1.50

Otherwise the description and figure of *P. kadiakensis* as given by Miss Rathbun does very well for *P. hiltoni*. On the whole *P. hiltoni* is the stouter of the two with less elongate and attenuate legs and a relatively shorter and stouter sixth abdominal segment.

Regarding the number of rostral teeth of *P. hiltoni*, as only four specimens have been seen, no positive statement can be made. Those examined all had nine teeth on the rostrum and an additional one on the carapace behind the orbit; beneath the number ranged from three in three of the specimens to four in the fourth one. In *P. kadiakensis* the count based on a large number of specimens ranges from six to ten teeth above, of which one or two are behind the orbit, and from two to three teeth below.

Dimensions.—Holotype (Cat. No. 48991, U. S. N. M.): length from tip of rostrum to end of telson 26 mm.; carapace and rostrum together 10.5 mm. The three paratypes are respectively 20, 21, and 24 mm. in length.

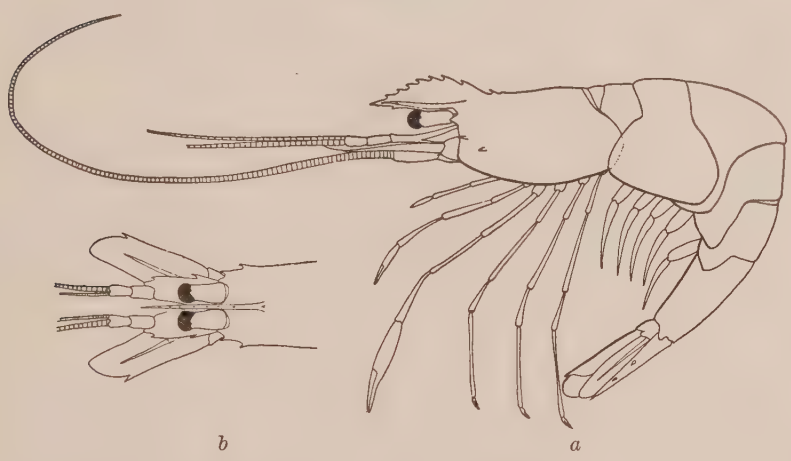
Type Locality.—San Pedro, California (Stout and Stafford coll.).

Genus **Urocaris** Stimpson

Rostrum prominently toothed above only. Carapace with an hepatic spine, with or without antennal spine, and without branchiostegal spine. Mandible without palp.

Urocaris infraspinis Rathbun

Urocaris infraspinis Rathbun, Proc. U. S. Nat. Mus., 24, 903, 1902; H. A. E., 10, 31, fig. 10, 1904.



b *a*

Fig. 22. *Urocaris infraspinis*, ♀, × 3⅕; *a*, lateral view; *b*, dorsal view of anterior portion (from Rathbun, U. S. N. M.).

Characters.—Rostrum about two-thirds as long as the carapace, pronouncedly convex above; armed with five to seven teeth, with one or two small teeth below near the tip; behind the rostrum there is a median gastric spine. Antennal and hepatic spines of good size; suborbital angle of carapace blunt. Ocular peduncles with a minute black ocellus above, towards the outside and beyond the limit of the cornea. Antennal scale much longer than the rostrum, with blade considerably exceeding the spine.

Dimensions.—Type, ovigerous female: length of carapace and rostrum 6 mm., of rostrum 2.5 mm., of abdomen 15 mm.

Type Locality.—Gulf of California, in Concepcion Bay, Lower California ("Albatross").

Distribution.—San Diego Bay, California; Gulf of California (Rathbun).

Family Pontoniidae

Rostrum laterally compressed and armed with teeth or depressed and unarmed. Antennules with one of the two flagella usually cleft a little distance from the tip. Mandible with incisor process but without palp. First pair of legs chelate and slender. Second pair chelate with one or both legs stouter or longer than first pair.

Key to the California Genera of the Pontoniidae

I. Rostrum short, less than one-half length of carapace, depressed, bent downward, not dentate. One of the second pair of legs with very large chela. (Known only from off Santa Cruz Island.)

Pontonia, p. 38.

II. Rostrum often about as long as carapace, compressed, usually dentate, not bent downward. Second pair of legs long, slender, and equal. (Not known north of Santa Catalina Island.)

Periclimenes, p. 39.

Genus **Pontonia** Latreille

Rostrum short, depressed, bent downward; not dentate; with or without a keel below at the free end. Both flagella of antennules short; thicker of the two bifid. Antennal scale of moderate length only, broad. One of the second pair of legs with very large chela.

Pontonia californiensis Rathbun

Pontonia californiensis Rathbun, Proc. U. S. Nat. Mus., **24**, 902, 1902; H. A. E., **10**, 33, fig. 11, 1904; Borradaile, Trans. Linn. Soc. London (Zool.), (2), **17**, 389, 391, 1917.

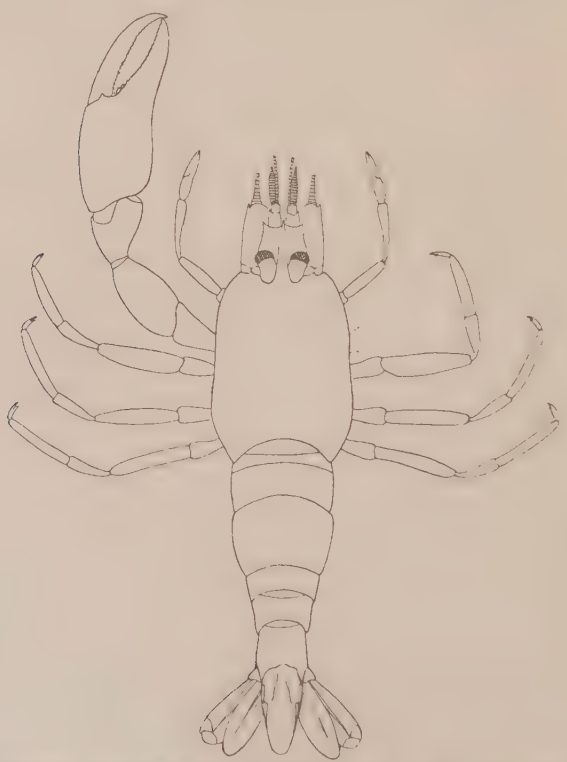


Fig. 23. *Pontonia californiensis*, ♀; dorsal view, × $4\frac{2}{7}$ (from Rathbun, U. S. N. M.).

Characters.—Rostrum more than one-third the length of the remainder of carapace, very narrow, deflexed. Right foot of second pair missing. Merus of left foot short and stout, carpus cup-shaped, palm and fingers subequal in length, palm two-thirds as broad as long, fingers gaping, prehensile edges denticulate, fringed with long hair. Telson twice as long as sixth somite, with two pairs of long lateral, appressed spines inserted on anterior half.

Dimensions.—Type, female: length of carapace and rostrum 6.7 mm., of rostrum 1.8 mm., of abdomen 9 mm.

Type Locality.—Off Santa Cruz Island, California, 30 fathoms ("Albatross" station 2945).

Remarks.—This is the only *Pontonia* described from the west coast of North America, the *P. margarita* of Smith being a *Conchodytes* (Rathbun).

Genus **Periclimenes** Costa

Rostrum long, compressed, usually dentate, in side view diminishing gradually to a sharp point at the free end, not bent downward. Thicker flagellum of antennules long or moderate, bifid. Antennal scale long, usually narrow. Second pair of legs long, slender, and equal.

Periclimenes tenuipes (Holmes)

Anchista tenuipes Holmes, Occas. Papers Calif. Acad. Sci., **7**, 216, 1900.
Periclimenes tenuipes Rathbun, H. A. E., **10**, 34, fig. 12, 1904; Borradaile, Trans. Linn. Soc. London (Zool.), (2), **17**, 368, 372, 1917.
Periclimenes holmesi Nobili, Ann. Mus. Univ. Napoli (N. S.), **2**, no. 21, 5, 1907; Borradaile, *ibid.*, (2), **17**, 376, 1917.

b *a*

Fig. 24. *Periclimenes tenuipes*, × 4; *a*, lateral view of carapace; *b*, foot of second pair (from Rathbun, U. S. N. M.).

Characters.—Rostrum about as long as the carapace, rather deep near the middle, armed above with six or seven teeth, the last one or two on the carapace; lower side armed with three or four teeth; the last dorsal spine is near the anterior third of the carapace. A supraorbital, an antennal, and an hepatic spine present; anterolateral angle of the carapace rounded and devoid of spines. Ocular peduncles large and furnished with an ocellus between the cornea and the proximal part of the stalk. Second pair of legs slender and greatly elongated, the carpus reaching beyond the rostrum; ischium, merus, and carpus of subequal length; hand long, very narrow, subcylindrical, exceeding the length of the carpus and merus combined; fingers slender, straight, about two-thirds as long as the palm; tips hooked and crossed when fingers are closed. Telson with two pairs of dorsal spinules.

Dimensions.—Type: length of body 18 mm., of second chelipeds 16 mm., of hand 7 mm., of carpus 3 mm.

Type Locality.—Santa Catalina Island, California.

Distribution.—From Santa Catalina Island, California, to Gulf of California (Rathbun).

Remarks.—The specimens in the U. S. National Museum, collected in the Gulf of California by the "Albatross," from which the above figure was taken, "agree with Holmes's description, except that the fingers of the second pair of feet are only a little over half as long as the palm and the posterolateral angle of the sixth abdominal segment is subacute" (Rathbun). Nobili (1917, p. 5) suggests the name *holmesi* for *Periclimenes tenuipes* (Holmes) which he says is preoccupied by *P. tenuipes* (Leach), but as there does not seem to be any original description I have retained Holmes's name. Borradaile says (1917, p. 376), "I have not been able to find the original description of it [*P. tenuipes* (Leach)]."

Family Pandalidae

Rostrum laterally compressed, long, and armed with teeth or spines. Mandibles with incisor process and palp of two or three segments. First pair of legs slender and usually simple, but often only apparently so, being at times microscopically chelate. Second pair long, slender, and chelate, with segmented carpus.

Key to the California Genera of the Pandalidae

I. Antennules not longer than the carapace. No laminate expansions on the merus of the third maxilliped and the ischium of the first legs.
Pandalus, p. 40.

II. Antennules twice the length of the carapace. Merus of third maxillipeds and ischium of first legs with a longitudinally developed laminate expansion fringed with long hairs.
Pandalopsis, p. 46.

Genus **Pandalus** Leach

Rostrum long and prominent, armed above with spines, which are for the greater part movable, and below with fixed and rigid teeth; rostrum continued backward upon the carapace as a median dorsal carina. Antennules not longer than the carapace. Mandible with a three-jointed palp. Second pair of legs unequal, with much segmented carpus.

None of the species at present known from California have median spines on the abdomen.

Key to the California Species of Pandalus

I. Dorsal spines not reaching behind middle of carapace; tip of rostrum acuminate, often with a small tooth behind the tip dorsally (*P. jordani* and *P. platyceros*), or trifid (*P. montagui tridens*).

A. Sixth segment of abdomen slender, about three times as long as wide. Carapace smooth and shining.

1. Rostrum with spines on distal half of superior margin, about one and three-fourths times as long as carapace, armed above with fourteen to seventeen spines, including four on the carapace, all movable except distal three; below with seven to ten immovable spines.

jordani, p. 41.

2. Rostrum unarmed on distal half of superior margin, slender, about one and one-half to one and four-fifths as long as carapace, armed above with ten to twelve movable spines, of which three to five are on the carapace, the remainder confined to the basal half of the rostrum (posterior spine just in front of middle of carapace) below with six to seven immovable spines.

montagui tridens, p. 42.

B. Sixth segment of abdomen short and stout, about one and one-half times as long as wide. Carapace pubescent. Rostrum one and one-half to one and two-thirds times the carapace. Median crest arising half way back on the carapace, armed with fourteen to seventeen spines, extending to middle of rostrum, all movable except one to five anterior ones; usually a solitary spine not far behind acute tip; seven to eight fixed spines below.

platyceros, p. 43.

II. Dorsal spines extending behind middle of carapace; tip of rostrum trifid.

A. Rostrum one and one-half times as long as carapace or more. Median dorsal spines eight to nine, all movable, rather distant; ventral spines nine to ten, immovable. Sixth segment of abdomen about one and one-half times as long as wide. (Not known north of Monterey Bay, or south of Santa Catalina Island.)

gurneyi, p. 46.

B. Rostrum less than one and one-half times as long as carapace. Median dorsal spines ten to twelve, movable; about half of them on the carapace, the posterior spine a little behind the middle; terminal half of rostrum, unarmed above; lower margin six to eight spines. Sixth segment of abdomen one and two-thirds as long as wide. (Not known south of San Francisco.)

danae, p. 44.

Pandalus jordani Rathbun

Plate 14, figure 1

Pandalus jordani Rathbun, Proc. U. S. Nat. Mus., **24**, 900, 1902; H. A. E., **10**, 40, pl. 2, fig. 3, 1904.

Characters.—Surface smooth and shining. Rostrum about one and three-fourths times as long as carapace, slightly arched above the eyes, terminal two-thirds ascending; slender; armed with fourteen to seventeen spines above, including four on the carapace, distal three immovable, others movable, closer together above the eye; seven to ten immovable spines below, extending nearer to tip than superior spines; tip acuminate; the posterior of the dorsal spines lies between the middle and the anterior third of the carapace. Antennal scale three-fourths to four-fifths as long as carapace, extremity of blade broadly

rounded, and equally produced with the spine. Right leg of second pair extends about to end of antennal scale; the left leg may be half again as long; the right carpus has nineteen to twenty-two segments, the left fifty-eight to sixty-three segments. Third segment of abdomen compressed and its posterior half carinated, the carina interrupted by a slight lobe at the posterior third of the segment; this lobe is of varying size, at no time strong, and has a tendency to disappear in large specimens, in which it may occur only as a slight unevenness in the curve, seen in profile; posterior margin well produced backward, rounded, unarmed; sixth segment of abdomen slender, about three times as long as wide.

Dimensions.—Type, ovigerous female: length 124.5 mm., length of carapace and rostrum 59.5 mm., of rostrum 38 mm.

Type Locality.—Off Santa Cruz Island, California, 155 fathoms ("Albatross" station 2949).

Distribution.—From Unalaska to off San Diego, California, 25 to 199 fathoms.

Remarks.—Distinguished from *P. borealis* (north Pacific and Atlantic), which has a similar rostrum, by the reduction of the abdominal lobe or hump and the absence of posterior median spines on third and fourth segments.

Biological Survey of San Francisco Bay.—Of the seventeen "outside" stations, *Pandalus jordani* was taken at seven, D 5785–5791, representing all of those at which the depth exceeded 29 fathoms. At four of the stations from one to eighteen specimens were taken, from each of the other three more than fifty were obtained. With but one exception the bottom was "very fine, green sand." From exceptional station, D 5791, very little bottom material was brought up other than "refuse and garbage." The ranges for temperature and salinity recorded at the time of making the various hauls were respectively 9.3° to 12.2° C and 33.9 to 34.4. *Crago alaskensis elongata* also occurred quite abundantly at each of these stations.

Pandalus montagui tridens Rathbun

Plate 13, figure 2

Pandalus montagui tridens Rathbun, Proc. U. S. Nat. Mus., 24, 901, 1902; H. A. E., 10, 41, pl. 2, fig. 2, 1904.

Characters.—Rostrum slender, from one and one-half to one and four-fifths times the length of carapace. Dorsal spines ten to twelve in number, all movable, three to five on the carapace and the remainder on the basal half of the rostrum; posterior spine just in front of middle of carapace; inferior spines six or seven, rigid; distal two-thirds of rostrum ascending, tip trifid. Antennal scale with outer margin slightly arcuate; blade truncate at tip, spine stout, reaching to or beyond the end of blade. Right leg of second pair with carpus divided into twenty to twenty-eight segments. Left leg of second pair with carpus divided into about seventy-four segments. Sixth segment of abdomen slender, about three times as long as wide.

Dimensions.—Type, female: length 104 mm.; length of carapace and rostrum 48.5 mm.; of rostrum 30.2 mm. The largest specimen on the Pacific Coast was taken off Point Arena, California, in 239 fathoms (''Albatross'' station 3349). It measures 110 mm. long, carapace and rostrum 53 mm., rostrum 34 mm. (Rathbun).

Type Locality.—Off North Head, Akutan Island, Alaska, 72 fathoms (''Albatross'' station 2842).

Distribution.—From Bering Sea to off San Nicolas Island, California, 3 to 1084 fathoms.

Remarks.—Miss Rathbun says:

I have separated this form from *P. montagui* Leach of the North Atlantic on account of its somewhat longer rostrum, which varies from one and a half to one and two-thirds times the carapace, the dorsal spines terminating behind the middle of the rostrum, while in typical *P. montagui* the rostrum is from one and two-fifths to one and a half times the carapace, and its dorsal spines reach to or in front of its middle. In *P. montagui* the tip is bifid; in the subspecies usually trifid.

Pandalus platyceros Brandt

Plate 14, figure 3

Pandalus platyceros Brandt *in* Middendorff, Reise in den äussersten Norden und Osten Sibiriens, Bd. II, Zool., Th. I, p. 123, 1851; Holmes, Occas. Papers Calif. Acad. Sci., 7, 210, 1900; Rathbun, H. A. E., 10, 44, 1904.

Characters.—Body stout. Carapace covered with a dense, short pubescence. Rostrum one and one-half to one and two-thirds times as long as carapace, provided with a broad, entire laminar crest on each side. Median crest arising halfway back on the carapace, armed with fourteen to seventeen spines extending to middle of rostrum, the anterior one to five spines fixed, the rest movable; usually a solitary spine not far behind the acute tip. Lower limb armed with seven or eight fixed spines, diminishing gradually in size; the basal tooth very large. Posterior part of rostrum deflexed, anterior half or two-thirds ascending, tip above level of carapace. Antennal scale four-fifths to seven-eighths as long as carapace, oblong, extremity of blade subtruncate, slightly exceeded by the spine. Right leg of second pair reaching to end of maxillipeds, carpus eight- to nine-jointed; left leg of second pair two-fifths again as long as right; carpus divided into twenty-seven or twenty-eight joints. Sixth segment of abdomen short and stout, one and one-half times as long as wide.

Dimensions.—Type: length of carapace 34.9 mm., of rostrum 38.1 mm., of abdomen 46.6 mm., of caudal appendages 19.1 mm.; total length 138.7 mm. Of an ovigerous female, length 214 mm., length of carapace and rostrum 113 mm., of rostrum 68 mm. (Rathbun).

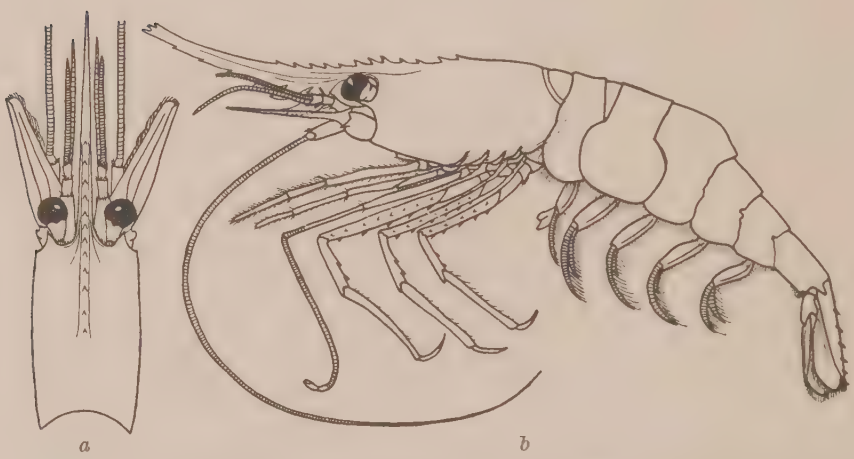
Type Locality.—Unalaska.

Distribution.—Unalaska to off San Diego, California, 25 to 266 fathoms. Japan (Balss). The 25-fathom record here cited was made off Portuguese Bend, near San Pedro, California, by the Venice Marine Biological Station.

Pandalus danae Stimpson

Plate 13, figure 3

Pandalus danae Stimpson, Proc. Boston Soc. Nat. Hist., **6**, 87, 1857; Jour. Boston Soc. Nat. Hist., **6**, 502 (62), pl. 21, figs. 6, 7, 1857; Rathbun, R., The Fisheries and Fishery Industries of the U. S., sec. 1, p. 281, 1884; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 209, pl. 4, figs. 61, 62, 1900; Rathbun, H. A. E., **10**, 47, fig. 13, 1904.



a *b*

Fig. 25. *Pandalus danae*, ♂, natural size; *a*, dorsal view of anterior end (proportional lengths of joints of antennular peduncle are not exact in lateral view, use this view); *b*, lateral view.

Characters.—A rather stout species. Surface finely pitted. Rostrum a little longer than the carapace (from one-fifth to one-eighth longer), distal two-thirds directed obliquely upward. Median dorsal spines ten to twelve, movable, about half of them on the carapace, the posterior spine a little behind the middle; terminal half of rostrum unarmed above, apex trifid; lower margin six- to eight-spined, the spines diminishing anteriorly; lateral carinae moderately prominent. Antennal scale from three-fourths to five-sixths as long as carapace, tapering to the extremity, the laminar part of which is rounded, and much exceeded by the spine. Right leg of second pair (exceeds antennal scale) may slightly exceed or fall short of the tip of the rostrum; merus slightly annulated; carpus with from eighteen to twenty-one joints, those of the proximal half very indistinctly marked; left leg one-third or nearly half again as long as right leg; merus and distal portion of ischium faintly annulated; about sixty carpal segments. Sixth segment of abdomen one and two-thirds as long as wide.

Dimensions.—Type: length 63.5 mm. The specimens taken in connection with the Bay Survey ranged between 55 and 114 mm. in length, exclusive of rostrum.

Type Locality.—Puget Sound.

Distribution.—From Sitka, Alaska, to San Francisco, California, 10 to 101 fathoms.

Biological Survey of San Francisco Bay.—Pandalus danae was found almost exclusively in the deeper portions of the middle bay, the region of greatest abundance being the outer central part of Golden Gate where three (D 5738, 5808, 5809) of the six stations from which it is recorded are located, and where 97 per cent of all the specimens caught were taken. The other three stations (D 5700, 5827, 5828) were made, one off Sausalito, one just to the westward of Alcatraz, and the third in mid-channel off the southern end of the east side of Angel Island (plate 5).

A summary of the above stations indicates quite a close correspondence between the depth, character of bottom, and the number of specimens obtained:

Station	Depth	Character of bottom	Number of specimens
D 5808	27–43	Coarse sand, gravel and stones, ranging up to 14 inches in length.	23
D 5738	23–60	Large rocks with very little coarse shelly sand.	3
D 5809	21½–53	Coarse sand, gravel and stones.	3
D 5700	17–19	Sand, coarse and fine gravel, broken shells.	2
D 5827	6–17	Clean, coarse sand and gravel, stones of all sizes up to width of hand and one-half inch thick at beginning, and sand and fine gravel and no stones at end of haul.	1
D 5828	10–16	Variegated mud, containing some sand and many shells at beginning, and sand and fine gravel with some shell fragments and living mollusks at end of haul.	1

As no specimen was taken at a temperature exceeding 12.2° C and none in a salinity less than 25.7 it is apparently the combination of the effects of higher temperature, lower salinity, shoaler water together with that of the character of the bottom which restricts the range of *Pandalus danae* in the bay, except in the section from which it is here recorded.

This is graphically demonstrable on the temperature and salinity curves figured by Sumner in his report upon the physical conditions in the Bay (1914, figs. B and M): The occurrence of this species far north of the southern shore of Angel Island, or at most the head of Raccoon Strait or south of Goat Island, would be restricted from January to July (periods I, II, III, and VI of Sumner) by rapid falling of the salinity below the minimum value, 25.7, established above, and from February to October (periods I, II, III, and IV) by the rise of temperature above 12.2° C. By the process of elimination only the months of November and December (period V of Sumner)

would have conditions of temperature and salinity favoring an extension of the range of *Pandalus danae,* but at this period as well as during the remainder of the year it is no doubt the absence of sufficient areas of favorable bottom elsewhere in the bay, together with the decrease in depth, that exercises the potent influence in restricting this species to the region of its observed distribution.

It is impossible to explain why no specimens of *Pandalus danae* were taken outside, for Dr. Rathbun says (1884, p. 821):

> This Prawn has been much more abundant in the San Francisco markets during the past two years than formerly, and the reason assigned is that the fishermen, driven out of San Francisco Bay by the constantly diminishing supply of fish there, have been forced to resort to the open sea between the Farallone Islands and Point Reyes, where the Prawns live in large numbers.

Pandalus gurneyi Stimpson

Plate 13, figure 1

Pandalus gurneyi Stimpson, Ann. Lyc. Nat. Hist., N. Y., **10**, 128, 1871; Rathbun, H. A. E., **10**, 50, pl. 2, fig. 6, 1904.

Characters.—Very near *P. danae.* Rostrum one and one-half to one and two-thirds longer than the carapace. Median dorsal spines eight or nine, all movable, rather distant; ventral spines nine or ten, immovable. Antennal scale as long as carapace. Right leg of second pair extends to tip of acicle, carpal segments seventeen; left leg one-third longer than right, carpal segments about forty-five. Sixth segment of abdomen one and one-half times as long as wide.

Dimensions.—Ovigerous female: length 77.5 mm., length of carapace and rostrum 38.5 mm., of rostrum 25 mm. (Rathbun).

Type Locality.—Monterey, California.

Distribution.—Monterey to San Pedro, and Santa Catalina Island, California, 9 to 55 fathoms.

Genus **Pandalopsis** Bate

Antennules twice the length of the carapace. Merus of third maxillipeds with inner margin longitudinally developed into a broad laminate expansion fringed with long hairs. Ischium of first pair of thoracic legs also with large laminate expansion, the lower margin of which is fringed with a row of hairs on the inner side.

Pandalopsis ampla Bate

Plate 14, figure 2

Pandalopsis amplus Bate, "Challenger" Rept., Zool., **24**, Macrura, p. 671, pl. 175, fig. 3, 1888.

Pandalopsis ampla Faxon, Mem. Mus. Comp. Zool., **18**, 155, 1895; Rathbun, H. A. E., **10**, 51, 1904.

Characters.—Surface remotely punctate. Rostrum one and one-third to one and nine-tenths as long as rest of the carapace (in small specimens it may be two and one-half times the carapace), slightly ascending, slightly arched above the eyes. Median crest occupying the anterior two-thirds of the carapace, armed with seven to thirteen movable spines, of which three to five are on the carapace and in front of the middle, the anterior spine considerably behind the middle of the rostrum. There is also a subterminal fixed spine; and occasionally two subterminal spines, both above, or one above and one below. Greater part of the rostrum unarmed above; lower margin armed with thirteen to sixteen slender spines, larger toward the base of the rostrum. Antennal scale four-fifths to eight-ninths as long as carapace; blade broadly rounded at the tip and exceeded by the spine. Ischium of first pair of feet is dilated in a thin, broad, laminar, inferior projection which is anteriorly lobiform. Feet of second pair equal, carpus with twenty to twenty-four segments; the right and left carpus may or may not have an equal number of segments; chela as long as the five adjacent segments of the carpus. Third segment of abdomen moderately produced backward in the middle, forming a lobe in the posterior margin; sixth segment nearly two and one-half times as long as wide, and about two-thirds as long as the telson.

Dimensions.—Of a specimen measured by Miss Rathbun: length 164 mm.; length of carapace and rostrum 85.7 mm.; of rostrum 87.6 mm.

Type Locality.—Off Monte Video, 600 fathoms ("Challenger").

Distribution.—From Washington to Mexico, and off Monte Video; 302 to 1084 fathoms.

Family Hippolytidae

Rostrum almost always a prominent feature, armed with teeth, and laterally compressed, usually well developed, sometimes, however, even shorter than the eye-stalks. Mandibles various, with incisor process and palp, or without either or both. First pair of legs chelate and moderately stout, stouter and shorter than second pair. Second pair chelate, slender, and equal, with segmented carpus.

Key to the California Genera of the Hippolytidae

I. Carpus of second pair of legs with more than seven segments. Mandible without incisor process or palp. (Not known north of Santa Barbara.)
Hippolysmata, p. 49.

II. Carpus of second pair of legs with seven segments. Mandible with incisor process and palp of two segments.
Spirontocaris, p. 50.

III. Carpus of second pair of legs with three segments. Mandible with incisor process but without palp.
Hippolyte, p. 47.

Genus **Hippolyte** Leach

Carpus of second pair of legs consisting of three segments. Mandible with an incisor process but without a palp. Carapace with a supraorbital spine.

Hippolyte californiensis Holmes

Hippolyte californiensis Holmes, Proc. Calif. Acad. Sci., (2), 4, 576, figs. 21–26, 1895; Occas. Papers Calif. Acad. Sci., 7, 193, 1900; Rathbun, H. A. E., 10, 56, 1904.

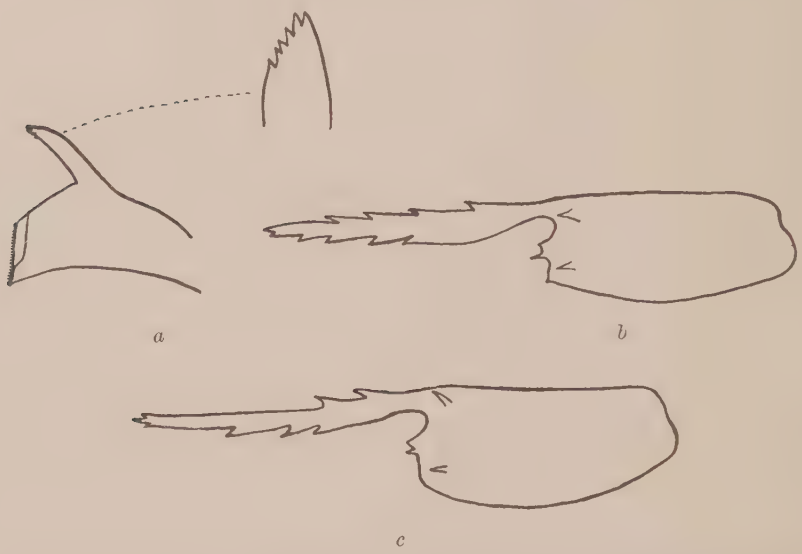


Fig. 26. *Hippolyte californiensis; a,* mandible; *b,* lateral view of carapace (from Holmes); *c,* lateral view of carapace, × 8, showing arrangement of rostral spines most commonly met with.

Characters.—Rostrum slender, a little longer than the carapace, armed both above and below with three to five, exceptionally six teeth; anterior tooth of each series usually situated immediately behind the acuminate tip, giving it a more or less trifid appearance; remaining teeth of upper series usually more or less bunched over the eye and confined to the basal half of the rostrum; base of rostrum rounded and not continued upon the carapace. Antennular peduncle about one-half as long as rostrum. Abdomen not crested or carinated; telson truncated and spinulous at the tip.

Dimensions.—Type: length 38 mm.

Color.—Green (Holmes).

Type Locality.—Bodega Bay, California.

Distribution.—From Sitka, Alaska, to San Diego, California (Rathbun).

Remarks.—"In a lot of eleven specimens from Puget Sound, the dorsal teeth are usually two, in one case three, on the basal half of the rostrum, and one or none near the tip. In a few individuals from San Diego the rostral teeth are typical" (Rathbun). In another lot of over fifty specimens received from the Venice Marine Biological Station, Venice, California, there is only one "typical" specimen. The rostrum figured by Holmes as the type seems to be a comparatively rare variation in the arrangement of the dorsal spines. With but three exceptions the rostral extremity of the Venice specimens is trifid; the exceptional specimens have a bifid rostrum.

Genus **Hippolysmata** Stimpson

Carpus of second pair of legs consisting of more than seven segments. No supraorbital spine. Antennules with two long flagella. Mandible without incisor process or palp.

Hippolysmata californica Stimpson

Hippolysmata californica Stimpson, Proc. Chicago Acad. Sci., **1**, 48, 1896; Ann. Lyc. Nat. Hist. N. Y., **10**, 123, 1871; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 180, pl. 2, fig. 38, 1900.

Fig. 27. *Hippolysmata californica*, lateral view of carapace (after Holmes).

Characters.—Rostrum slender, strongly ridged on the sides, bent downward near the base, about one-half as long as the carapace; armed above with six or seven teeth, the last tooth situated at considerably more than the usual interval from the preceding one and at about the anterior third of the carapace; below armed with three teeth. Flagella of the antennules subequal and longer than the body. Second pair of legs very long and slender; ischium stouter than the merus and about as long, more or less annulated towards the tip; merus divided into something over twenty annulations; carpus about as long as merus and ischium combined and divided into about thirty-two annulations; hand minute, oblong, the fingers scarcely as long as the palm. Telson subacute, much shorter than the uropods.

Dimensions.—Type: length 31.8 mm.

Color.—Very conspicuously marked with longitudinal stripes of drab and reddish brown (Holmes). Abdomen in life striped longitudinally with red; stripes anteriorly, on carapace, bending obliquely upward; greater part of tail-fan a deep mahogany color, with tips of uropods and telson bluish; antennules, antennae and legs light reddish brown; eggs of ovigerous female light pea-green.

Type Locality.—San Diego, California.

Distribution.—Santa Barbara to San Diego, California (Rathbun).

Remarks.—Found abundantly in tide pools. The teeth on the under side of the rostrum are quite inconspicuous, and are not indicated in the figure taken from Holmes, above.

Genus **Spirontocaris** Bate

Carpus of second pair of legs consisting of seven segments, mandible with incisor process, and palp of two segments.

Key to the California Species of Spirontocaris

I. One or more supraorbital spines present.
  A. Rostrum roughly subcircular; three, more rarely two, supraorbital spines. (Not known south of Monterey.)
    prionota, p. 52.
  B. Rostrum not subcircular, more or less elongate; one or two supraorbital spines.
    1. One supraorbital spine.
      a. Rostrum comparatively prominent, longer than eye; supraorbital spine relatively small.
        i. Rostrum less than twice as long as the eye; armed above with four spines, two of which are on the carapace, below with three teeth on anterior third. (Known only from 448 + fathoms.)
          washingtoniana, p. 55.
        ii. Rostrum twice or more than twice as long as the eye; armed above with ten teeth, last three of which are on the carapace, below with six teeth, all of which are in front of the middle of the rostrum. (Only one specimen known, from Monterey.)
          affinis, p. 56.
      b. Rostrum inconspicuous, reduced to a spine on frontal margin, much shorter than the eye, supraorbital spines a very prominent feature; behind rostral spine anterior half of carapace is carinated and bears three spines. (Known only from Laguna Beach.)
        lagunae, p. 57.
    2. Two supraorbital spines.
      a. Abdominal segments laterally acute. Rostrum shorter than remainder of carapace. Dorsal spines continued posterior to middle of carapace; spines on carapace proper four. (Not known south of Point Arena.)
        lamellicornis, p. 53.
      b. First three abdominal segments laterally rounded.
        i. Rostrum longer than remainder of carapace. Dorsal spines continued at least to or beyond middle of carapace; spines on carapace proper two or three.
          bispinosa, p. 54.
        ii. Rostrum shorter than, rarely as long as, remainder of carapace.
          a. Dorsal spines all in front of middle of carapace, spines on carapace proper two. (Known only from 211 + fathoms.)
            sica, p. 55.
          b. Dorsal spines continued posterior to middle of carapace; spines on carapace proper three or four.
            snyderi, p. 54.

II. No supraorbital spine or spines.

A. Rostrum as long as or longer than rest of carapace.

1. Terminal half (at least) of rostrum devoid of spines above. Sixth abdominal segment not longer than the telson.

a. Sixth abdominal segment less than twice as long as wide. Rostrum deep, one-fourth as deep as long. (Not known north of Monterey Bay.)

carinata, p. 62.

b. Sixth abdominal segment more than twice as long as wide. Rostrum more slender.

i. Scale at base of antennules extending beyond first segment. Third maxilliped with epipod. (Not known south of Drake's Bay.)

flexa, p. 58.

ii. Scale at base of antennules not reaching beyond or only slightly beyond first segment. Third maxilliped without epipod. (Not known south of Santa Catalina Island.)

gracilis, p. 59.

2. Terminal half of rostrum with spines (in part, at least).

a. Sixth abdominal segment longer than telson.

decora, p. 61.

b. Sixth abdominal segment shorter than telson.

i. Third maxillipeds exceeding antennal scale. Rostrum with six to eight spines above.

paludicola, p. 64.

ii. Third maxillipeds not exceeding antennal scale.

a. Rostrum with more than eight spines above. (Within California region known only from Monterey Bay.)

layi, p. 63.

b. Rostrum with five or six spines above.

i. Third maxillipeds reaching about to the middle of the antennal scale. (Not known north of San Francisco Bay or south of Laguna Beach.)

franciscana, p. 60.

ii. Third maxillipeds reaching nearly to end of antennal scale. (Not known south of Santa Cruz.)

kincaidi, p. 63.

B. Rostrum shorter than rest of carapace.

1. Rostrum elongate, reaching beyond middle of antennal scale.

a. Upper and lower limbs of rostrum deep and with convex margins. (Known only from 178 + fathoms.)

macrophthalma, p. 72.

b. Upper and lower margins of rostrum not both convex.

i. Upper margin of rostrum concave; rostrum armed above with six teeth, the last one of which is on the carapace; below with three teeth. (Known only from 266 + fathoms.)

brachydactyla, p. 72.

ii. Upper margin of rostrum straight; rostrum armed above with six to seven teeth, the last two of which are on the carapace; below with two to four teeth. (Not known north of Monterey Bay.)

picta, p. 68.

2. Rostrum short, not reaching beyond middle of antennal scale.
   a. Rostrum not reaching as far as cornea. (Not known north of San Francisco Bay.) *taylori*, p. 67.
   b. Rostrum reaching as far as or beyond the cornea.
      i. Rostrum not reaching second segment of antennular peduncle.
         a. Antennal scale about equal in length to or shorter than the telson. (Not known south of San Francisco Bay.) *brevirostris*, p. 66.
         b. Antennal scale longer than the telson. (Not known north of San Francisco Bay.) *palpator*, p. 65.
      ii. Rostrum reaching second segment of antennular peduncle and usually beyond. *cristata*, p. 69.

As can be seen above, the species of *Spirontocaris* dealt with in this paper arrange themselves readily into four groups based on the number of supraorbital spines; the last of these groups has been subdivided for convenience, owing to the number of species included in it.

I. Group with more than two supraorbital spines, p. 52.
II. Group with two supraorbital spines, p. 53.
III. Group with one supraorbital spine, p. 55.
IV. Group with no supraorbital spines.
   a. Rostrum as long as or longer than remainder of carapace, p. 58.
   b. Rostrum shorter than remainder of carapace, p. 65.

I. Group with more than two supraorbital spines.

Spirontocaris prionota (Stimpson)

Hippolyte prionota Stimpson, Proc. Acad. Nat. Sci. Phila., **16**, 153, 1864; Kingsley, Bull. Essex Inst., **14**, 127, pl. 2, fig. 9, 1883.

Spirontocaris prionota Walker, Trans. Liverpool Biol. Soc., **12**, 277, 1898; Holmes (mis-spelled *prionata*), Occas. Papers Calif. Acad. Sci., **7**, 206, 1900; Rathbun, H. A. E., **10**, 61, 1904.

Fig. 28. *Spirontocaris prionota*, lateral view of carapace and abdomen (adapted from Kingsley).

Characters.—Carapace with two or three supraorbital spines in a longitudinal series; dorsally crested nearly to the posterior margin and armed with three teeth, the anterior margins of which are armed on either side with a short, transverse row of small spines. Rostrum shorter than the carapace, lamelliform, very deep though not so deep as long; general outline roughly subcircular; anterior

and dorsal margin minutely serrated, with spinuliform teeth, lower margin with four or five small simple teeth. Abdominal segments laterally rounded, except the fourth and fifth which have the posterolateral angle produced into an acute tooth. Dactyls of ambulatory legs about one-half as long as their propodi.

Dimensions.—Type: length about 35 mm.

Type Locality.—Puget Sound.

Distribution.—From Bering Sea to Monterey, California, to 80 fathoms (Rathbun). Japan (Balss).

Remarks.—To Kingsley's figure one must add two or three supraorbital spines arranged in a longitudinal series. While three seems to be the normal number the anterior one is often reduced and sometimes wanting (Rathbun). Easily distinguished from the other North Pacific lamelli-rostral species by serrate margin of dorsal teeth, and rostrum (Stimpson).

II. Group with two supraorbital spines.

Spirontocaris lamellicornis (Dana)

Hippolyte lamellicornis Dana, Proc. Acad. Nat. Sci. Phila., **6**, 24, 1852; Crust. U. S. Expl. Exped., **1**, 576, 1852, pl. 36, fig. 6, 1855.

Spirontocaris lamellicornis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 208, 1900; Rathbun, H. A. E., **10**, 62, fig. 18, 1904.

Fig. 29. *Spirontocaris lamellicornis,* ♀, lateral view of carapace, × 1⅗ (from Rathbun, U. S. N. M.).

Characters.—Abdominal segments laterally acute. Rostrum with mid-rib horizontal or but slightly ascending, about three-fourths as long as the rest of the carapace, broad and lamellate, continued backward nearly to posterior margin of carapace. Median spines of carapace proper four, rather larger than the rostral teeth which number about six above; below there are two teeth, of which the anterior forms the lower of the two teeth forming the bifid tip of the rostrum. Dactyls of the last pair of ambulatory legs about half as long as their propodi.

Dimensions.—Types: length 38 to 50.8 mm.

Type Locality.—Dungeness, Straits of Fuca.

Distribution.—This species occurs sparingly from Unalaska to Point Arena, California, 9 to 77 fathoms (Rathbun).

Remarks.—The number of supraorbital spines for this species as figured by Dana is only one. This is either an error or an abnormality for an examination of all the U. S. National Museum material of this species fails to show any exception to the rule of two supraorbital spines. Dana also has the first abdominal segment laterally rounded, which is only exceptionally the case; as a rule it is acute.

Spirontocaris bispinosa Holmes

Spirontocaris bispinosa Holmes, Occas. Papers Calif. Acad. Sci., **7**, 207, 1900; Rathbun, H. A. E., **10**, 68, fig. 23, 1904.

Fig. 30. *Spirontocaris bispinosa*, ♀, lateral view of carapace, × 2 (from Rathbun, U. S. N. M.).

Characters.—Rostrum a little longer than remainder of carapace. Distal half of rostrum a slender, styliform process, with a strong upward trend, devoid of teeth above and with a single tooth below. Basal half of rostrum high and laminate, continued backward over the anterior two-thirds of the carapace as a carina, armed above with ten to twelve teeth which decrease in size and become more closely set anteriorly, there being several small teeth crowded together where the rostrum is abruptly narrowed; the two posterior dorsal teeth are the two median spines of the carapace proper; below the basal half of the rostrum is armed with three or four low teeth. First three abdominal segments laterally rounded. Dactyls of ambulatory legs about one-half as long as their propodi.

Dimensions.—Of an ovigerous female, approximate length 59.5 mm., length of carapace and rostrum 25.2 mm., of rostrum 14.8 mm. (Rathbun).

Type Locality.—Puget Sound.

Distribution.—From Yes Bay, Alaska, to off San Diego, California, 13 to 211 fathoms.

Spirontocaris snyderi Rathbun

Spirontocaris snyderi Rathbun, Proc. U. S. Nat. Mus., **24**, 894, 1902; H. A. E., **10**, 69, fig. 24, 1904.

Fig. 31. *Spirontocaris snyderi*, ♀, lateral view of carapace, × 2⅘ (from Rathbun, U. S. N. M.).

Characters.—Median spines of the carapace proper three or four; between these spines and the small ones on the rostrum there is a considerable space; rostral teeth five or six above and three or four below. Rostrum a little shorter than remainder of the carapace, much the shape of that of *S. bispinosa* except that the mid-rib is more rapidly ascending and ends in a short point and that the upper lamina is more shallow and of rather even depth. First three abdominal segments laterally rounded. Dactyls of ambulatory legs one-third as long as their propodi or less than one-third.

Dimensions.—Type, ovigerous female: approximate length, 28 mm.; length of carapace and rostrum 9.4 mm., of rostrum 4.4 mm.

Type Locality.—Monterey Bay, California.

Distribution.—Puget Sound to Lower California, 44 to 77 fathoms (Rathbun).

Remarks.—This species bears a curious resemblance to *S. bispinosa;* in general terms it is a *bispinosa* with the slender spine of the rostrum broken off; but a closer examination shows other and more radical differences (Rathbun).

Spirontocaris sica Rathbun

Spirontocaris sica Rathbun, Proc. U. S. Nat. Mus., 24, 894, 1902; H. A. E., 10, 69, fig. 25, 1904.

Fig. 32. *Spirontocaris sica,* ♀, lateral view of carapace, × 1⅗ (from Rathbun, U. S. N. M.).

Characters.—Near *S. bispinosa.* Posterior median tooth of carapace considerably in front of middle. Rostrum shorter than in *S. bispinosa;* upper and lower laminae narrower and extending nearer the tip; armed with nine to fourteen teeth above (in *S. bispinosa* ten to twelve), the last two of which are on the carapace; below with three to five teeth on the lamina (as in *S. bispinosa*), but none on the slender terminal portion. First three abdominal segments laterally rounded. Dactyls of ambulatory legs about one-third as long as their propodi.

Dimensions.—Type, female: length 58 mm.; length of carapace and rostrum 24.8 mm., of rostrum 12.8 mm.

Type Locality.—Santa Barbara Channel, 265 fathoms ("Albatross" station 3200).

Distribution.—Off the coast of California, from Point Arena to San Diego, 211 to 464 fathoms (Rathbun).

III. Group with one supraorbital spine.

Spirontocaris washingtoniana Rathbun

Spirontocaris washingtoniana Rathbun, Proc. U. S. Nat. Mus., 24, 895, 1902; H. A. E., 10, 76, fig. 30, 1904.

Fig. 33. *Spirontocaris washingtoniana,* ♀, lateral view of carapace, × 2⅕, (from Rathbun, U. S. N. M.).

Characters.—Carapace stout, carinated in its anterior half; posterior median spine situated at the anterior fourth of the carapace. Rostrum slender, half as long as the carapace, reaching just to end of first segment of the antennules, nearly horizontal, slightly sinuous; dorsal spines four, two of which are on the carapace; anterior two-fifths of rostrum unarmed above, armed below with three teeth on anterior third, one tooth close to the tip; except for the teeth the rostrum is scarcely limbed above or below. Basal scale of antennules about two-thirds as long as the first segment of the peduncle. Abdomen narrow compared with carapace; posterior margin of third segment is moderately produced; sixth segment one and one-half times as long as fifth, and a little more than one-half as long as the telson.

Dimensions.—Type, female: length 39 mm., of carapace and rostrum 14 mm., of rostrum 5 mm.

Type Locality.—Off Sea Lion Rock, Washington, 685 fathoms ("Albatross" station 3071).

Distribution.—Has also been taken east of San Clemente Island, California, 448 to 468 fathoms ("Albatross" station 4401; 1 ♀).

Spirontocaris affinis (Owen)

Hippolyte affinis Owen, *in* Zoology of Captain Beechey's Voyage (in the "Blossom"), Crustacea, p. 90, pl. 27, fig. 4, 1839; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 194, 1900.

Spirontocaris affinis Rathbun, H. A. E., **10**, 77, 1904.

Fig. 34. *Spirontocaris affinis*, lateral view of anterior portion (after Owen).

Characters.—Depth of rostrum greater than one-third but not quite equal to half its length; rostrum shorter than the antennules but exceeding their peduncles; armed above with ten more or less evenly spaced, subequal teeth, the last three of which are on the carapace; armed below with about six teeth, all in front of the middle of the rostrum. The spine on the outer side of the base of the antennules exceeds the first segment of the peduncle in length. Fifth segment of abdomen laterally unarmed.

Dimensions.—Type: length 38 mm.

Color.—Red (Owen).

Type Locality.—Monterey, California.

Remarks.—Has not been reported since Owen's original description.

Spirontocaris lagunae sp. nov.

Plate 12, figures 10 and 11

Fig. 35. *Spirontocaris lagunae*, ♀, mandible, much enlarged.

Description.—Carapace about one-half as long as abdomen, exclusive of telson; surface with small, scattered tufts of setae. Rostrum very small, reduced to a mere spiniform tooth; supraorbital spine well developed, prominent, reaching beyond the frontal margin of the carapace by about half the length of the eye-stalk; behind the rostrum the carapace is more or less carinated, carina bearing three teeth on anterior half of carapace, and fading out toward posterior margin; of these teeth the median is much the largest, being about twice the size of the other two, which are subequal; posterior tooth at about the middle of the carapace; anterolateral margin with subocular, antennal and branchiostegal spines. Antennular peduncle reaching forward about half the length of the antennal scale, flagella attaining its extremity; antennal peduncle about as long as or slightly longer than antennular peduncle. Mandible with incisor process and palp of two segments. Third pair of maxillipeds exceeding the antennal peduncle but falling short of the tip of the scale. Carpus of second pair of legs with seven segments. Propodi of ambulatory legs spinulous below, dactyls with five corneous spines, increasing in size to the last or terminal one; terminal spine and the one next adjacent subequal, making the dactyl appear biunguiculate.

First three abdominal segments laterally rounded; epimera of fourth somewhat, and fifth pronouncedly drawn out into a backward pointing, acute, spine-tipped process, armed on the posterior margin with a second spine a little distance above the first; postero-ventral angle of sixth segment prolonged into a strong, stout spine, above which, on the posterior margin, there is a much shorter, weaker one; on the ventral surface of this segment there is a blunt, conical tubercle, at about the anterior fourth of the median line; dorsal surface of telson with three pairs of spinules.

Dimensions.—Type (Cat. No. 52711, U. S. N. M.), ovigerous female: length about 20 mm.

Color.—Type, "kelp color" (Hilton). The label on two other specimens also collected by Prof. W. A. Hilton reads: "Body light, legs darker, red and black on appendages."

Type Locality.—Known only from two ovigerous females and one male specimen dredged at Laguna Beach, California, by Prof. W. A. Hilton. Of these the male and one female were taken August 27, 1917, in 12 to 15 fathoms.

Remarks.—From the great development of the supraorbital spines it would appear that this species is referable to the genus *Alope* White, from which it differs, however, in having a mandibular palp of only two segments instead of three as is characteristic of that genus.

IV. Group with no supraorbital spines.

Section a. Rostrum as long as or longer than remainder of carapace. (In this subgroup, with the exception of *S. paludicola,* the third maxillipeds do not exceed the antennal scale. In *S. gracilis, flexa, carinata,* and *franciscana* the third maxillipeds reach about to the middle of the antennal scale or only slightly beyond the middle. In *S. decora* they extend well beyond the middle and in *S. kincaidi* nearly to the end of the scale, but in neither do they quite attain its end or at all exceed it. In *S. paludicola,* mentioned above, the third maxillipeds slightly exceed the tip of the antennal scale. The length of the third maxillipeds of *S. layi* is not known.) (For section b, see p. 65.)

Spirontocaris flexa Rathbun

Spirontocaris camtschatica Rathbun, The Fur Seals and Fur-Seal Islands of the North Pacific Ocean, pt. III, p. 557, 1899, not *S. camtschatica* (Stimpson).

Spirontocaris flexa Rathbun, Proc. U. S. Nat. Mus., 24, 986, 1902; H. A. E., 10, 78, fig. 32, 1904.

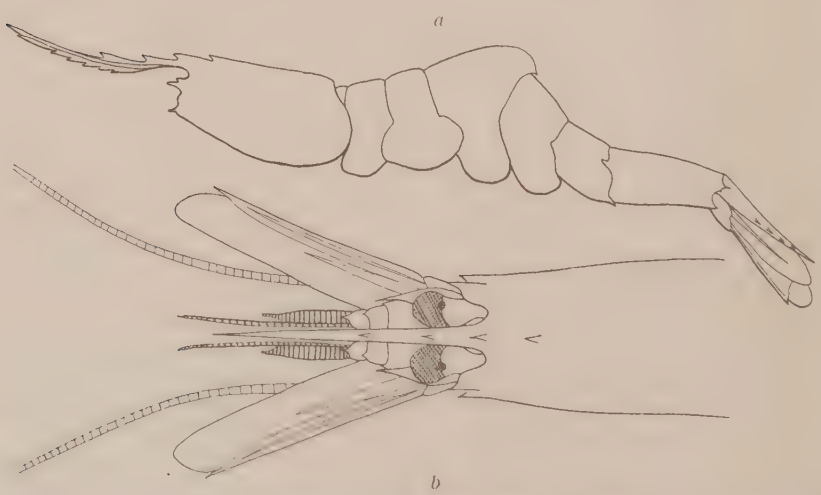


Fig. 36. *Spirontocaris flexa,* ♀; *a,* lateral view of carapace and abdomen, × 2½; *b,* dorsal view of anterior portion, × 3¾ (from Rathbun, U. S. N. M.).

Characters.—Rostrum slender, armed with four or five teeth above, including one or two on the carapace, anterior tooth near middle of rostrum; anterior half of rostrum not limbed above; lower limb narrow and armed with from five to eight spines. Basal spine of the antennules extends beyond the first segment of the peduncle. The abdomen is strongly geniculated at the third segment, which is posteriorly produced and compressed, forming a smooth, rounded carina; sixth segment more than twice but not three times as long as wide, and shorter than the telson.

Dimensions.—Type, female: length 54 mm.; of carapace and rostrum 20 mm.; of rostrum 11.5 mm.

Type Locality.—North of Bird Island, Shumagins, Alaska, 21 fathoms ("Albatross" station 2850).

Distribution.—From Bering Sea to Drake's Bay, California, 20 to 93 fathoms (Rathbun).

Remarks.—This species is very near *S. gracilis,* from which it differs in the longer basal scale of the antennules, in the lower position of the pterygostomian spine, in the presence of epipods on the maxilliped and first two pairs of feet (Rathbun).

Spirontocaris gracilis (Stimpson)

Hippolyte gracilis Stimpson, Proc. Acad. Nat. Sci. Phila., **16,** 155, 1864.
Heptacarpus tenuissimus Holmes, Occas. Papers Calif. Acad. Sci., **7,** 203, 1900.
Heptacarpus? gracilis Holmes, *ibid.,* **7,** 205, 1900.
Spirontocaris gracilis Rathbun, H. A. E., **10,** 77, fig. 31, 1904.

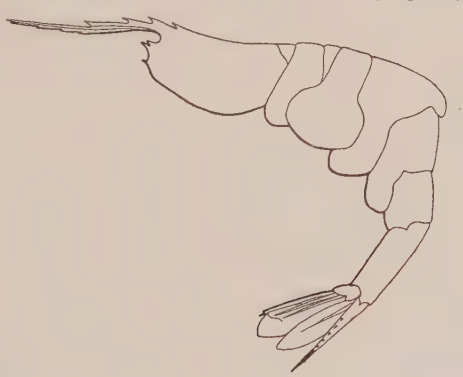


Fig. 37. *Spirontocaris gracilis,* ♀, lateral view, × 2 (from Rathbun, U. S. N. M.).

Characters.—Rostrum very slender, similar to that of *S. flexa,* scarcely higher than wide; armed above with four spines, the posterior on the carapace, the anterior near middle of rostrum; armed below with four or five small distant teeth. The spine on the outer side of the base of the antennules does not reach beyond, or only slightly beyond the first segment of the peduncle. Third maxilliped without an epipodite (see *Remarks*). Abdomen strongly geniculated or bent at a right angle at the third segment, which is posteriorly produced and compressed forming a smooth, rounded carina; sixth segment more than twice but not three times as long as wide, and not longer than the telson.

Dimensions.—Type: length 31.8 mm.

Type Locality.—Puget Sound.

Distribution.—From the Shumagins, Alaska, to Santa Catalina Island, California, 21 to 47 fathoms.

Remarks.—This is, so far as known, the only *Spirontocaris* from the west coast of America in which the third maxilliped lacks an epipodite.

Biological Survey of San Francisco Bay.—Spirontocaris gracilis was taken at three outside stations, D 5785, 5786, 5791, which were

made at a depth of 29 to 40 fathoms, in close correspondence with its known bathymetric range (see *Distribution* above). The bottom at the first two of these stations was "very fine, dark green sand," at the last one practically nothing but "refuse and garbage." The range of bottom temperature at these stations was 9.6° to 9.8° C; the range of salinity, 34.2 to 34.3.

Spirontocaris franciscana sp. nov.

Plate 12, figures 8 and 9

Description.—Rostrum about one-fourth longer than the carapace, only slightly exceeding the antennal scale; armed above with five teeth, the last of which is situated on the carapace, while the most anterior is slightly more than one-third, about two-fifths, the length of the rostrum from the tip; armed below with six to seven teeth, the most anterior of which is the smaller and is situated immediately behind the acute tip, thus giving the rostral extremity a bifid appearance. The suborbital angle of the carapace is prominent and the antennal spine is well developed, but there is no trace of a pterygostomian spine.

Thinner flagellum of the antennules exceeds the blade of the antennal scale by as much as the blade exceeds the spine; thicker flagellum extends four-fifths the length of the antennal scale; basal scale of antennules not reaching beyond proximal margin of the first segment of the peduncle. Antennal peduncle reaching about as far forward as the antennular peduncle; antennal scale (measured along outer margin) about equal to the carapace in length.

The maxillipeds about reach or just fall short of the middle of the antennal scale. First pair of feet reach as far forward as the eyes, the second exceed the maxillipeds by the length of the hand, the third pair by about one-third the length of their propodal joints, and the fourth pair by the length of their dactyli, while the last or fifth extend only as far forward as the tips of the maxillipeds. This species, like *S. stylus*, has an epipod but no exopod on the third maxilliped, and has all the thoracic feet without epipods.

Abdomen strongly geniculated at the third segment, which is more or less evenly rounded above; sixth segment shorter than the telson; telson with four to six pairs of lateral spinules.

Dimensions.—Type (Cat. No. 50439, U. S. N. M.), ovigerous female: length 46 mm., of carapace and rostrum 17 mm., of rostrum 10 mm.

Color.—"Plain reddish brown (pale)." Taken from the label of a specimen collected by Prof. W. A. Hilton at Laguna Beach.

Type Locality.—San Francisco Bay ("Albatross" station D 5770).

Distribution.—San Francisco Bay and Laguna Beach, California, 2¼ to 7½ fathoms.

Remarks.—This species is close to *Spirontocaris stylus* of Stimpson (see Rathbun, 1904*a*, p. 84, for description), and like it lacks a pterygostomian spine, but differs, however, in that the teeth of the dorsal margin of the rostrum extend forward onto its distal half; the rostrum too, is shorter, and the antennal peduncle longer in *S. franciscana*, which also, withal, is the stouter and more robust species of the two.

One of the San Francisco Bay specimens (the single one taken at D 5778) has the anterior dorsal tooth at the middle of the rostrum, and did it not coincide so closely in all other points, I should be inclined to doubt its identity.

Biological Survey of San Francisco Bay.—Only four specimens of this species were taken in the bay; three in 5 to 7½ fathoms, from the "rough, rocky bottom" to the eastward of Point Bonita (D 5770); and one also from a hard bottom of "fine clean gray sand, and medium sized rounded stones" in 2½ to 3½ fathoms on the bay side of Fort Point (D 5778).

Spirontocaris decora Rathbun

Spirontocaris decora Rathbun, Proc. U. S. Nat. Mus., 24, 896, 1902; H. A. E., 10, 79, fig. 33, 1904.

Fig. 38. *Spirontocaris decora,* ♀, lateral view, × 3 (from Rathbun, U. S. N. M.).

Characters.—Sixth abdominal segment longer than the telson, nearly three times as long as wide. Rostrum longer than the carapace, armed above with four or five teeth, of which one or two are on the carapace, anterior tooth in front of middle of rostrum. Rostrum not deep, but less slender than in *S. gracilis* and *S. flexa,* a little concave above, but nearly horizontal; lower limb narrowing distally from near posterior end, armed with six to eight teeth; tip acuminate. Basal spine of antennules reaching about to end of first segment of the peduncle. Posterior margin of third segment of abdomen is produced backward in the middle, and the segment itself is posteriorly prominent but not laterally pinched or carinated as in allied species.

Dimensions.—Type, female: approximate length 47 mm., length of carapace and rostrum 16.4 mm., of rostrum 9 mm.

Type Locality.—Off Santa Cruz Island, California ("Albatross" station 2946).

Distribution.—From Straits of Fuca to San Diego, California, 50 to 171 fathoms (Rathbun).

Spirontocaris carinata (Holmes)

Heptacarpus carinatus Holmes, Occas. Papers Calif. Acad. Sci., 7, 202, pl. 3, fig. 60, 1900.
Spirontocaris carinata Rathbun, H. A. E., 10, 84, 1904.

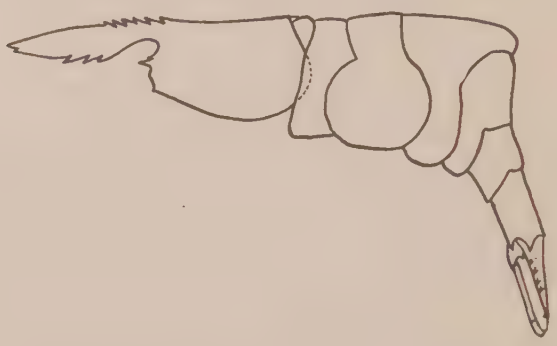


Fig. 39. *Spirontocaris carinata,* lateral view of carapace and abdomen (after Holmes).

Characters.—Rostrum deep, one-fourth as deep as long; armed above with four to six small teeth, the posterior one on the carapace, the anterior one a little behind the middle of the rostrum, below with four to six teeth, the anterior of which is commonly near the tip. Basal spine of the antennules reaches about to the tip of the first segment of the peduncle. Third segment of abdomen is posteriorly produced and crested; sixth less than twice as long as wide, and shorter than the telson.

Dimensions.—Single specimen in the U. S. National Museum: length from tip of rostrum to end of telson 48 mm., of rostrum 9 mm., of carapace 9 mm., of telson 6 mm.

Color.—Varies with surroundings. Specimens among bright green seaweeds are of a uniform bright green color, while the specimens living only a few yards away among the red seaweeds imitate almost exactly the color of the algae that surround them (Holmes).

Type Locality.—Monterey Bay, California.

Distribution.—From Monterey Bay, shallow water (Holmes), to Point Loma, California (''Albatross'' one specimen) (Rathbun). I have also seen a specimen dredged at Laguna Beach by Prof. W. A. Hilton in 10 to 15 fathoms.

Remarks.—The eyes of this species are very slender. The antennular peduncles extend about one-third the length of acicle (Rathbun).

Spirontocaris kincaidi Rathbun

Spirontocaris kincaidi Rathbun, Proc. U. S. Nat. Mus., **24**, 899, 1902; H. A. E., **10**, 95, fig. 43, 1904.

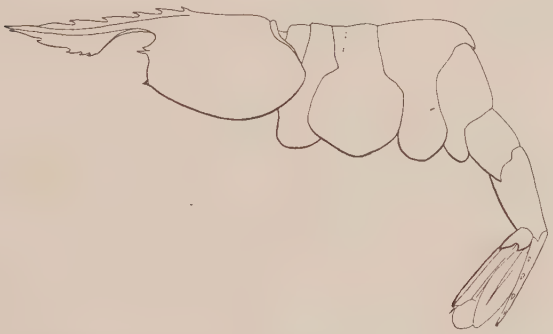


Fig. 40. *Spirontocaris kincaidi*, ♀, lateral view, × 2½ (from Rathbun, U. S. N. M.).

Characters.—Carapace short in relation to the abdomen. Rostrum one-third longer than the carapace, not reaching tip of antennal scale, slightly concave above, horizontal; armed above with five, occasionally six teeth, two of which are on the carapace, anterior dorsal tooth a little in front of the middle of the rostrum; tip acute; lower limb tapering from a point in front of the eye to the tip, armed with five teeth, one subterminal. Basal spine of the antennules reaching distal margin of the second segment of the peduncle. Posterior margin of the third abdominal segment is produced backward into a pronounced lobe; the abdomen is strongly bent at this point; the fourth segment is spineless; the sixth is barely twice as long as wide or high, and a little shorter than the telson.

Dimensions.—Type, ovigerous female: approximate length 36.5 mm., length of carapace and rostrum 13.6 mm., of rostrum 7.7 mm.

Type Locality.—Off Santa Cruz, California, 21 fathoms (''Albatross'' station 3124).

Distribution.—Puget Sound to San Pedro, California, 21 to 100 fathoms.

Spirontocaris layi (Owen)

Hippolyte layi Owen, *in* Zoology of Captain Beechey's Voyage (in the ''Blossom''), Crustacea, p. 90, pl. 27, fig. 3, 1839; Bate *in* Lord's Naturalist in British Columbia, **2**, 279, 1866; Lockington, Bull. Essex Inst., **10**, 161, 1878.

Spirontocaris layi Rathbun, H. A. E., **10**, 96, 1904.

Fig. 41. *Spirontocaris layi*, lateral view of anterior portion (after Owen).

Characters.—Rostrum armed above with about ten unequally spaced teeth, the last three of which are on the carapace; below with four or five nearly equal teeth in front of the middle of the rostrum.

Dimensions.—Type: length, 63.5 mm.

Color.—Red (Owen).

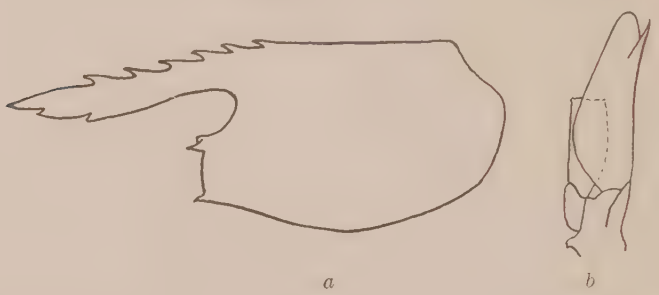
Type Locality.—Monterey, California.

Distribution.—Monterey, California (Owen), Esquimalt Harbor, Vancouver Island (Bate).

Spirontocaris paludicola (Holmes)

Heptacarpus paludicola Holmes, Occas. Papers Calif. Acad. Sci., **7**, 201, pl. 3, figs. 56, 57, 1900.

Spirontocaris paludicola Rathbun, H. A. E., **10**, 101, 1904.



a *b*

Fig. 42. *Spirontocaris paludicola; a,* lateral view of carapace; *b,* acicle (after Holmes).

Characters.—Third maxillipeds exceeding the antennal scale. Rostrum slender, about as long as carapace, reaching nearly to or slightly beyond the end of the antennal scale, armed above with six to eight evenly spaced teeth, the last tooth on the anterior fourth of the carapace; armed below with two to four teeth on the distal third or two-fifths of the rostrum. Third segment of the abdomen smoothly rounded above, not carinate or with posterior margin produced; sixth segment about one and one-third or one-half times as long as wide and shorter than the telson, which is shorter than the antennal scale.

Dimensions.—Length of the specimens taken in San Francisco Bay ranged from 22 to 32 mm., from tip of rostrum to end of telson.

Color.—Uniform green (Holmes).

Type Locality.—Humboldt Bay, California.

Distribution.—British Columbia to San Diego, California.

Remarks.—Occasional specimens of this species have been found with the rostrum shorter than the carapace and antennal scale as well, a rare and apparently abnormal condition. In such cases, in preserved material, it is quite difficult to distinguish the species from *S. picta.* However, the rostrum always reaches about to the middle of the thicker flagellum of the antennules or beyond, while in *S. picta* the rostrum only slightly exceeds the antennular peduncle, if at all. On the whole, *S. paludicola* runs larger in size. In specimens of relatively the same size the rostrum and acicle are comparatively longer in *S. paludicola;* the teeth on the lower side of the rostrum are apparently not quite so bunched near the tip as in *S. picta,* but are more widely and evenly separated; the sixth abdominal segment is longer and comparatively not quite so stout; and the posterior ambulatory legs are much more slender than in *S. picta.*

Biological Survey of San Francisco Bay.—Spirontocaris paludicola was found in shallow water, in patches of eel grass along the Raccoon Strait's shore of Angel Island, where one specimen was taken by means of a boat-dredge in 2 to 5½ fathoms (D 5763), and among the algal growths in pools on the tidal flats north of the Standard Oil pier, Richmond, where also only a single specimen was obtained.

IV. Group with no supraorbital spines—(Continued)

Section b. Rostrum shorter than the carapace, not exceeding three-fourths its length. (In this subgroup the third maxillipeds exceed the antennal scale except in occasional specimens of *S. picta,* in which the maxillipeds attain but fail to reach beyond the tip of the antennal scale, and in *S. macrophthalma,* in which they fall short of the tip of the antennal scale. In *S. taylori, palpator* and *brevirostris* the third maxillipeds exceed the tip of the antennal scale by the whole, or the greater part of the terminal joint, and occasionally in some adults of the two latter species by the two last joints of the maxillipeds. In *S. cristata* and the greater number of specimens of *S. picta* the third maxillipeds only slightly exceed the antennal scale. In *S. brachydactyla* the third maxillipeds exceed the antennal scale by half the length of the last joint. The basal spine of the antennules in all the above species usually reaches to about the middle of the second segment of the peduncle, except in *S. macrophthalma* and *S. brachydactyla;* in the former it does not quite reach the end of the first segment, while in the latter it varies from being slightly shorter to slightly longer than the first segment of the antennular peduncle.) (For section a, see p. 58.)

Spirontocaris palpator (Owen)

Hippolyte palpator Owen, *in* Zoology of Captain Beechey's Voyage (in the "Blossom"), Crustacea, p. 89, pl. 28, fig. 3, 1839.

Heptacarpus palpator Holmes, Occas. Papers Calif. Acad. Sci., **7**, 196, pl. 3, figs. 48, 49, 1900.

Spirontocaris palpator Rathbun, H. A. E., **10**, 98, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 69, 1916; *ibid.*, **10**, 54, 1918.

a *b*

Fig. 43. *Spirontocaris palpator; a,* lateral view of carapace; *b,* acicle (after Holmes).

Characters.—Antennal scale longer than the telson; antennal peduncle reaching about to the middle of the scale. Rostrum reaching cornea or beyond, but not exceeding first segment of antennular peduncle; armed above with four to seven teeth, the last two or three of which are on the carapace; below without teeth or a small one near the tip; tip of rostrum usually simple, sometimes bifid or trifid.

Dimensions.—Type: length 46.6 mm.

Color.—Red (Owen). Almost transparent; red on the thorax in one case, body streaked with brownish in another; still another with body violet and appendages deep pink; in a fourth instance the body had a light pink tinge.

Type Locality.—Monterey, California.

Distribution.—San Francisco Bay, California, to Magdalena Bay, Lower California.

Remarks.—This species and the one following (*S. brevirostris*) are very similar in general appearance and are undoubtedly closely related. They can always be distinguished by the length of the antennal scale as compared with the telson; it is always longer than the telson in *S. palpator;* it may be equal, but never exceeds the telson in *S. brevirostris,* often falling short of it. *S. brevirostris* is relatively the much stouter and more robust species of the two, attaining also a much greater size. To emphasize these differences the following table, based on four of the largest specimens of each species in the U. S. National Museum collections, is inserted.

All measurements in mm.	Locality	Length of carapace	Length of abdomen (over all)	Length of third maxillipeds	Length of antennal scale	Length of telson
S. palpator	San Pedro	8	17	12	4	3.5
S. palpator	Pacific Grove	9	19	15	5	4.0
S. palpator	San Diego	9	19	20	5	4.5
S. palpator	San Diego	10	21	20	6	5.0
S. brevirostris	San Francisco Bay	14	28	37	7	7.0
S. brevirostris	Kadiak, Alaska	14	30	25	7	8.0
S. brevirostris	San Francisco Bay	15	32	31	7	8.0
S. brevirostris	Unalaska, Alaska	17	35	43	8	8.0

In eleven of a series of fourteen specimens of *S. palpator,* the tip of the rostrum had a simple ending, tip in one bifid and in two trifid.

Spirontocaris brevirostris (Dana)

Hippolyte brevirostris Dana, Proc. Acad. Nat. Sci. Phila., **6**, 24, 1852; Crust. U. S. Expl. Exped., **1**, 566, 1852, pl. 36, fig. 5, 1855.

Heptacarpus brevirostris Holmes, Occas. Papers Calif. Acad. Sci., **7**, 198, pl. 3, figs. 50, 51, 1900.

Spirontocaris brevirostris Rathbun, H. A. E., **10**, 99, 1904.

a *b*

Fig. 44. *Spirontocaris brevirostris; a,* lateral view of carapace; *b,* acicle (from Holmes).

Characters.—Antennal scale about the same length or shorter than the telson; antennal peduncle reaching about two-thirds the length of the scale. Rostrum reaching cornea or beyond, but not exceeding first segment of antennular peduncle; armed above with five or six teeth, the last three or four of which are on the carapace; below without teeth; tip of rostrum simple, very exceptionally bifid.

Dimensions.—Types: length of body 31.8 to 38 mm.

Color.—Uniform light crimson or scarlet (Stimpson).

Type Locality.—Dungeness, Straits of Fuca.

Distribution.—Attu, Aleutian Islands, to San Francisco Bay, California (Rathbun).

Remarks.—I have examined a series of about seventy specimens of this species and find that practically all have the antennal scale about as long as the telson; ten had the antennal scale shorter than the telson. In all but one the tip of the rostrum ended simply; in this single exception it was clearly bifid, owing to the fact that the first rostral spine was situated immediately above the acute tip.

Biological Survey of San Francisco Bay.—Only two specimens of *Spirontocaris brevirostris* were taken in the bay; one along the southern shore of Golden Gate in 2¼ to 3½ fathoms, in company with *S. taylori* at D 5778, and one near the head of Raccoon Strait in 13 to 19 fathoms at D 5795. The bottom in both cases was more or less rocky, characterized by considerable algal growth in the case of the former.

Spirontocaris taylori (Stimpson)

Hippolyte taylori Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 500, 1857.
Heptacarpus taylori Holmes, Occas. Papers Calif. Acad. Sci., **7**, 199, pl. 3, figs. 52, 53, 1900.
Spirontocaris taylori Rathbun, H. A. E., **10**, 101, 1904.

a *b*

Fig. 45. *Spirontocaris taylori; a*, lateral view of carapace; *b*, acicle (after Holmes).

Characters.—Rostrum very short, not reaching even to the cornea, extending very little beyond the anterior margin of the carapace, armed above with five or six teeth, the last three or four situated on the carapace; anteriorly the teeth become more inclined forward, the end of the rostrum appearing curved downward although the lower margin is horizontal; unarmed below. Antennal scale about as long as telson.

Dimensions.—The Biological Survey specimens listed below ranged between 11 and 28 mm. in length, from tip of rostrum to end of telson.

Type Locality.—Monterey, California.

Distribution.—San Francisco Bay, California, to Magdalena Bay, Lower California (Rathbun).

Remarks.—Distinguished by the extreme shortness of the rostrum (Stimpson). *S. taylori* though approaching *S. brevirostris* never attains so large a size and always retains its characteristic rostrum in which the last two teeth, immediately following the acute tip, are above rather than behind it.

Biological Survey of San Francisco Bay.—The localities at which *Spirontocaris taylori* was taken were always characterized by an abundant growth of algae. This species was dredged from among the rocks, in 2 to 5 and possibly 7 fathoms along both shores of Golden Gate: two specimens at D 5770, on the north side east of Point Bonita, and two and six specimens respectively, at D 5777 and 5778 on the south side, east of Fort Point. Five other specimens were washed from bunches of seaweed stripped from the piles of the Sausalito Ferry building.

Spirontocaris picta (Stimpson)

Hippolyte picta Stimpson, Ann. Lyc. Nat. Hist., N. Y., **10**, 125, 1871.
Heptacarpus pictus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 200, pl. 3, figs. 54 and 55, 1900.
Spirontocaris picta Rathbun, H. A. E., **10**, 101, 1904.
Heptacarpus pictus Baker, Rep. Laguna Mar. Lab., **1**, 106, 1912.

Fig. 46. *Spirontocaris picta; a*, lateral view of carapace; *b*, acicle (after Holmes); *c* and *d*, variations in spining of rostrum; *e*, mandible (after Baker).

Characters.—Rostrum reaches beyond the middle of the antennal scale but does not exceed three-fourths its length, about equals or slightly exceeds the antennular peduncle; armed above with six or seven quite evenly spaced teeth, the last two of which are on the carapace; armed below with two to four teeth near the tip. Antennal scale about as long as the telson.

Dimensions.—Type: length 33.8 mm.

Color.—Thorax obliquely streaked with crimson (Stimpson). Greenish, semi-transparent, with oblique reddish marks on carapace (Baker).

Type Locality.—Monterey, California.

Distribution.—Monterey Bay to San Diego, California (Rathbun).

Remarks.—Abundant in tide pools (Baker). The rostrum is more slender over the eyes and the teeth on the under side appear to be closer together than seems to be the case in *S. paludicola.*

Spirontocaris cristata (Stimpson)

Hippolyte cristata Stimpson, Proc. Acad. Nat. Sci. Phila., **12**, 33, 1860; not *H. cristatus* de Haan, 1849.

Heptacarpus cristatus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 202, pl. 3, figs. 58, 59, 1900.

Spirontocaris cristata Rathbun, H. A. E., **10**, 102, fig. 45, 1904.

Fig. 47. *Spirontocaris cristata; a,* lateral view of carapace (after Holmes); *b,* chela, ♂, × 10⅔; *c,* chela, ♀, × 10⅔ (from Rathbun, U. S. N. M.).

Characters.—Rostrum reaching second segment of the antennular peduncle and beyond, usually to the tip of the peduncle, only rarely reaching beyond the middle of the antennal scale; nearly straight above, but slightly arched over the eye where the dorsal teeth are most thickly set; dorsal teeth five to eight, the last two or three of which are on the carapace, the most anterior tooth situated at some distance from the tip; below there are one, two, or three teeth near the tip. Antennal scale longer than the telson. Dactyls of ambulatory legs very long and slender, more than one-third, about one-half the length of their propodi. This character will serve to distinguish *S. cristata* from all the other species given in this subgroup.

Dimensions.—Type: length 25.4 mm. The Bay specimens were from 8 to 32 mm. in length over all.

Type Locality.—San Francisco, California.

Distribution.—From Sitka, Alaska, to San Diego, California, 3 to 33 fathoms (Rathbun).

Remarks.—The male differs peculiarly from the female. It has the customary points of difference: It is smaller and more slender; the rostrum is more slender and slightly overlaps the second antennular segment instead of reaching to the end of it. The most striking character is the unusual length of the fingers which exceed the palm in length and are rather slender, giving the chelae a *Palaemon*-like appearance; in the female, on the contrary, the fingers are considerably shorter than the palm, as in most species of the genus (Rathbun).

Biological Survey of San Francisco Bay.—Spirontocaris cristata is essentially a middle and lower bay form (see plate 6). It was taken at somewhat over one-fourth of the dredging stations in both of these sections (21 middle and 10 lower, or 29% and 26% respectively) and at from one-ninth to one-seventh of the hydrographic stations made in the same divisions (12 middle and 15 lower or 11% and 14% respectively). In the upper bay it was taken at but one of twenty-two dredging stations (D 5715; 4%) and at only one of eighty hydrographic stations (H 5264; 1%). Outside the bay *Spirontocaris cristata* was taken only at three of the seventeen dredging stations made there (D 5731, 5791, and 5807; 18%).

The range of distribution within the region covered by the bay survey may be briefly stated, as, from Pinole Point (H 5264) in the upper bay to Point San Mateo in the lower bay (D 5748) and outside to about the 30-fathom line (D 5791).

From the percentages given above this species is apparently more of a bottom dweller than an inhabitant of the upper water layers, being taken about twice as frequently in the dredge as in the tow-net hauls. With respect to the character of bottom preferred there seems to be little choice as the dredging stations are about equally divided between those with a more or less hard bottom, sand, gravel, shells or rocks, and mud. However, when the average number of specimens per catch is considered, the lower bay with its quite uniformly muddy bottom seems to be the region of greatest abundance. In the lower bay an average of fourteen and four-tenths specimens per dredge haul were taken as compared with two and two-tenths for the middle bay, two for the single haul made in the upper bay, and two per haul for both of the outside stations. This is also shown, though not so strikingly, when the tow-net hauls for each region are treated in a like manner, in the lower bay the average number of specimens per catch being four and eight-tenths, for the middle bay three and five tenths, for the upper bay one, outside, none.

Furthermore, aside from showing that *Spirontocaris cristata* is found more abundantly near the bottom than near the surface, the averages just given corroborate in another way what has just been brought out, that the muddy bottom of the lower bay seems to be preferred by this species. In the lower bay the highest average per catch is with the dredge hauls while in the middle bay, where the bottom is not so uniformly muddy or not at all muddy in some parts, this relation is reversed, although only to a slight degree, the average

number of specimens per catch with the dredge being two and two-tenths and for the tow-net three and five-tenths. The upper bay is muddy like the lower bay and its single dredge and tow-net catches exhibit a relation corresponding to that shown in the lower bay.

The highest temperature prevailing at the time of making any particular catch was 19.4° C (H 5216, upper bay); the lowest, 7.6° C (H 5311, lower bay). The highest salinity recorded, 34.3, was naturally outside (D 5791); the lowest, 22.5, was in the upper bay (D 5715). It seems hardly necessary to state that owing to the character of the collecting apparatus employed the figures given above represent surface readings in the case of the hydrographic stations and bottom readings in the case of the dredging stations.

At only three hydrographic stations, one in each of the major portions of the bay, was *Spirontocaris cristata* taken alone. Usually it was associated with one species of *Crago,* frequently with two or three, and rarely with four. Some species of *Cancer* were found in all but three of the dredge hauls, and "crab megalopa" were obtained in sixteen of the twenty-eight tow-net hauls (H stations). Three specimens of *Spirontocaris cristata* were obtained in company with *S. taylori* from algae stripped from the piles of the Sausalito Ferry building.

There are three specimens of juvenile *Spirontocaris* taken from as many hydrographic stations (H 4996, 5122, 5217) which I shall briefly refer to here under *Spirontocaris cristata* as most probably belonging to this species. The last one was taken in the tow-net just off the north end of Raccoon Strait; the other two in mid-channel off the southeastern shore of Angel Island. The surface temperatures of these stations, taking the time of making the haul into consideration, ranged from 13.8° to 14.6° C, the surface salinity from 20.82 to 32.29. The first of these hauls was made in February, the second in May, and the last in October. In view of the great lapse of time between all three of these records, February to October, it is surprising that the young stages of *Spirontocaris* were not represented more often in the bay collections.

The following is a complete list of the stations at which *Spirontocaris cristata* was taken: D 5702, 5705, 5715, 5723, 5726, 5730, 5732, 5739, 5743–5748, 5754, 5755, 5762, 5766–5768, 5772, 5773, 5778, 5779, 5791, 5795, 5799, 5802, 5803, 5807, 5809, 5828, 5829, 5847, 5848; H 4996, 5005, 5010, 5015, 5091, 5094, 5098, 5099, 5101, 5102, 5112, 5115, 5117, 5120, 5123, 5128, 5134, 5138, 5163, 5165, 5186, 5188, 5216, 5264, 5298, 5299, 5311, 5317, 5319; and Sausalito, March 19, 1912.

Spirontocaris brachydactyla Rathbun

Spirontocaris brachydactyla Rathbun, Proc. U. S. Nat. Mus., 24, 898, 1902; H. A. E., 10, 93, fig. 41, 1904.

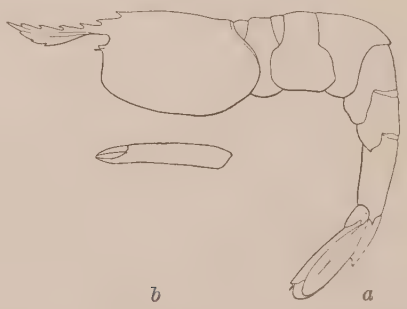


Fig. 48. *Spirontocaris brachydactyla*, ♀; *a*, lateral view of carapace and abdomen, × 3; *b*, chela of first pair, × 5 (from Rathbun, U. S. N. M.).

Characters.—Rostrum distinctly shorter than the carapace; armed above with six teeth, the last of which is on the carapace; armed below with three. Fingers of chelae of first pair of legs very short, not more than one-third as long as the palm. No spine on fourth segment of abdomen. Telson broken.

Dimensions.—Of type, ovigerous female: length, exclusive of rostrum and telson 24.8 mm.; length of carapace 7.7 mm.

Type Locality.—Off Santa Cruz Island, 266 fathoms (''Albatross'' station 2948).

Distribution.—Southern California, 266 to 417 fathoms (Rathbun).

Spirontocaris macrophthalma Rathbun

Spirontocaris macrophthalma Rathbun, Proc. U. S. Nat. Mus., 24, 900, 1902; H. A. E., 10, 105, fig. 48, 1904.

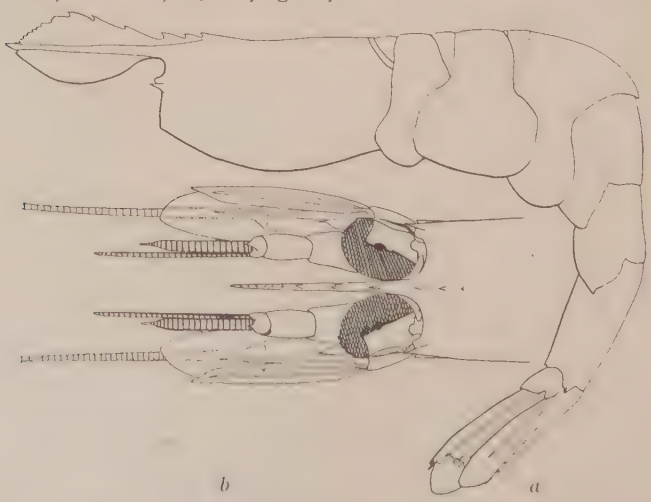


Fig. 49. *Spirontocaris macrophthalma; a*, lateral view of carapace and abdomen, ♂, × 2; *b*, dorsal view of anterior portion, ♀, × 2½ (from Rathbun, U. S. N. M.).

Characters.—Carapace carinated in its anterior half, posterior spine at the anterior fifth; upper line of carapace and mid-rib of rostrum nearly horizontal; rostrum about three-fourths or five-sixths as long as the carapace, upper and lower limbs with convex margins and widest at about the middle of their length; armed above with ten to fourteen teeth, the last two or three of which are on the carapace; armed below with one to three spines; tip acute. Eyes large, pyriform; cornea extending on inner side almost to the base of the peduncle. Blade of antennal scale exceeding the spine considerably, most advanced toward its inner margin.

Dimensions.—Type, female: length 62.6 mm.; length of carapace and rostrum 24 mm.; of rostrum 11 mm.

Type Locality.—Off Tawhit Head, Washington, 178 fathoms ("Albatross" station 3076).

Distribution.—From the north coast of Unalaska eastward and southward to Point Sur, California, 178 to 636 fathoms (Rathbun).

Remarks.—The males exhibit the usual differences from the females (described above) in being more slender, in the longer antennular flagella, and in the abdominal appendages (Rathbun).

Family Crangonidae (Alpheidae)

Rostrum very small or wanting. Eyes covered by the carapace. Mandibles with incisor process and palp of two segments. First pair legs chelate, with one or both chelae powerfully developed. Second pair of legs minutely chelate, long, slender, and equal, with segmented carpus. Telson broad and rounded.

As the genera of Weber (*Nomenclator entomologicus,* 1795) complying with the International Code of Zoological Nomenclature are to be accepted as valid (vide Smithsonian Publ. 1938, 1910) I have followed Miss Rathbun's findings (Proc. Biol. Soc., Washington, **17**, 170, 1904*b*) and have given *Crangon* precedence over *Alpheus* Fabricius. Hence the name of the family to which this genus belongs becomes Crangonidae and the family formerly bearing that name must needs be changed. For it Miss Rathbun (*op. cit.*) has supplied Cragonidae (p. 81), based on the genus *Crago,* in place of the former genus *Crangon.*

Key to the California Genera of the Crangonidae

I. Rostrum present, short and pointed; hands normal, dactyl of larger hand opening either vertically or horizontally; front either unispinose or trispinose.

A. No pterygostomian spine. Thoracic feet with epipods; dactyli simple. (Not known north of the Farallon Islands.)

Crangon, p. 74.

B. Pterygostomian spine present. Thoracic feet without epipods; dactyli bifid. (Not known north of Santa Monica Bay and Santa Catalina Island.)

Synalpheus, p. 77.

II. Rostrum wanting; hands inverted so that dactyls are on lower side; front not spined, either emarginate between the eyes or evenly rounded. (Not known north of Point Arena.)

Betaeus, p. 79.

Genus **Crangon** Weber

Rostrum short and usually spiniform. Antennules with basal article and spine reduced. Distal joint of third maxillipeds drawn out to a point and almost unarmed. No pterygostomian spine on carapace. Thoracic legs with epipods; dactyli simple.

Key to the California Species of Crangon

I. Front trispinose; rostrum present, orbital hoods armed with spines.
  A. Basal joint of antennae with a spine.
    1. Merus joints of third and fourth pair of legs with a spine below at inferodistal angle. A sulcus between eye-shields and rostrum. Large hand sculptured, dactyl closing horizontally. Smaller hand with a superior spine above articulation of dactyl only, no external spine. (Not known north of Farallon Islands.)
    dentipes, p. 74.
    2. No spines on merus joints of third and fourth pairs of legs; no sulcus between eye-shields and rostrum.
      a. Dactyl of larger hand closing horizontally, laminate. Large hand sculptured; smaller hand spined. (Not known north of Monterey.)
      bellimanus, p. 75.
      b. Dactyl of larger hand closing vertically. Large hand smooth; smaller hand without spines. (From Monterey to Santa Barbara.)
      equidactylus, p. 76.
  B. Basal joint of antennae without a spine. Smaller hand with a superior spine above articulation of dactyl, no external spine. As no specimen, only the original description, has been seen it is not known how the dactyl of the larger hand opens. (Known only from Santa Barbara.)
  barbara, p. 76.

II. Front unispinose; rostrum present, but no spines on orbital hoods. A deep sulcus between eye-shields and rostrum. Smaller hand smooth without spines; dactyl of larger hand opening vertically. (Not known north of San Pedro.)
californiensis, p. 76.

Crangon dentipes (Guérin)

Alpheus dentipes Guérin, Exp. Sci. Morée, Zool., p. 39, pl. 27, fig. 3, 1832.
Alpheus clamator Holmes, Occas. Papers Calif. Acad. Sci., **7**, 182, pl. 2, figs. 39, 40, 1900; Baker, Rep. Laguna Mar. Lab., **1**, 106, 1912.
Alpheus dentipes Rathbun, H. A. E., **10**, 108, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 67, fig. 6, 1916.

a *b*

Fig. 50. *Crangon dentipes; a,* small hand; *b,* large hand (after Holmes).

Characters.—Merus joints of third and fourth pairs of legs with a spine below at the inferodistal angle. Front trispinose; rostrum present and orbital hoods each armed with a spine; a sulcus between the eye-shields and the rostrum. Large hand sculptured, dactyl closing horizontally; small hand with a superior spine above the articulation of the dactyl only, no external spine. Basal spine of antennules shorter than first joint of peduncle. Carpus of second pair of legs with first and second segments equal.

Dimensions.—Length of an ovigerous female in the collection of the U. S. National Museum from tip of rostrum to end of telson 35 mm.; length of carapace and rostrum 11 mm.; length of large hand 19 mm.

Color.—In alcohol a light flesh tint, much deeper on the large hand. A darker spot on the upper surface of the carapace, also on the anterior edge of the first two abdominal segments (Lockington).

Type Locality.—"Sapience, ėt au cap Tenare; golfe de Genes" (Guérin).

Distribution.—Farallon Islands, California, to San Bartholome Bay, Lower California. Mediterranean; Cape Verde Islands; Bermudas; Porto Rico; Cuba; Key West (Rathbun).

Remarks.—This species lives in pools on rocky reefs at low tide level, and is capable of producing, by clapping together the fingers of the larger hand, a snapping noise like that which can be made with the finger nail (Lockington). Common in sponge masses and kelp holdfasts (Baker).

Crangon bellimanus (Lockington)

Alpheus bellimanus Lockington, Proc. Calif. Acad. Sci., **7**, 34, 1877; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 184, pl. 2, fig. 41, 1900; Rathbun, H. A. E., **10**, 108, 1904.

Fig. 51. *Crangon bellimanus,* large hand (after Holmes).

Characters.—Front trispinose; rostrum present and orbital hoods each armed with a spine; no sulcus between eye-shields and rostrum. Large hand sculptured, dactyl laminate, closing horizontally. Small hand with a superior spine on upper margin at articulation of dactyl and an external spine on outer surface at base of dactyl. Basal spine of antennules short, not reaching second joint of peduncle. Carpus of second pair of legs with first segment about as long as the next two combined.

Dimensions.—Type: length from point of rostrum to end of abdomen 30.3 mm.; length of larger hand 12.7 mm., of smaller 9.7 mm.

Color.—The present species may be easily recognized by the beautiful coloring of its hands, which in a dried specimen are orange, with various spots and workings of black and white. The carapace presents similar coloration to that of the hands (Lockington).

Type Locality.—San Diego, California, found among the kelp.

Distribution.—From Monterey to San Diego, California (Rathbun); Chile (Coutière).

Crangon barbara (Lockington)

Alpheus clamator Kingsley (not Lockington), Bull. U. S. Geol. Surv., **4**, no. 1, p. 197, 1878.

Alpheus barbara Lockington, Ann. Mag. Nat. Hist. (5), **1**, 471, 1878; Rathbun, H. A. E., **10**, 108, 1904.

Characters.—Basal joint of antennae without a spine. Small hand with a superior spine above articulation of dactyl, no external spine. Basal spine of antennules short, stout, not reaching second joint of peduncle. Carpus of second pair of legs with first and second segments equal.

Type Locality.—Santa Barbara, California.

Remarks.—According to Coutière probably the same as *A. macrocheles* (Hailstone) (Rathbun). Kingsley did not give any measurements of his type, which was an imperfect specimen. The species has not been seen since the original description.

Crangon californiensis (Holmes)

Alpheus californiensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 186, pl. 2, fig. 42, pl. 3, figs. 43, 44, 1900.

a *b* *c*

Fig. 52. *Crangon californiensis; a,* large hand; *b,* dorsal view of anterior portion of carapace; *c,* small hand (after Holmes).

Characters.—Front unispinose; rostrum present, but orbital hoods without spines; a deep sulcus between eye-shields and rostrum. Small hand smooth. Basal spine of antennules broadly ovate, acuminate, scarcely reaching tip of first joint of peduncle. Carpus of second pair of legs with first segment long, exceeding second.

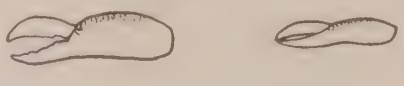
Dimensions.—Type: length 37 mm.; length of carapace 12.5 mm., of large hand 15 mm., of small hand 9 mm.

Type Locality.—San Pedro, California.

Distribution.—Also found at Magdalena Bay, Lower California, by C. R. Orcutt.

Crangon equidactylus (Lockington)

Alpheus equidactylus Lockington, Proc. Calif. Acad. Sci., **7**, 35, 1877; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 187, pl. 3, figs. 45, 46, 1900; Rathbun, H. A. E., **10**, 108, 1904.



a *b*

Fig. 53. *Crangon equidactylus; a,* large hand; *b,* small hand (after Holmes).

Characters.—Front trispinose; rostrum present and orbital hoods each armed with a spine; no sulcus between eye-shields and rostrum. Hands oblong, narrow, compressed, smooth, without spines; a transverse sulcus crossing the upper edge of the hand behind the dactyl, from which a longitudinal sulcus extends backward on the upper edge of the larger hand almost to the posterior margin, but about two-thirds as far in the smaller one; dactyl of large hand closing vertically. Basal spine of the antennules stout, extending to end of second joint of peduncle. Carpus of second pair of legs with first segment as long as the next four combined.

Dimensions.—Type, length 19.1 mm.

Type Locality.—Monterey, California.

Distribution.—Monterey to Santa Barbara, California.

Remarks.—According to Coutière this is *Alpheopsis trispinosus* of Stimpson (Rathbun).

Genus **Synalpheus** Bate

Rostrum short and usually spiniform. Antennules with basal joint longest; basal spine wide, equal to sum of first two joints. Distal joint of third maxillipeds elongate, armed with strong spinules at tip. Carapace with a pterygostomian spine. Thoracic legs without epipodites; dactyli bifid.

Synalpheus lockingtoni Coutière

Plate 12, figure 1

Alpheus leviusculus Lockington, Ann. Mag. Nat. Hist. (5), **1**, 479, 1878, not *A. edwardsi* var. *leviusculus* Dana, 1852.

Alpheus lockingtoni Coutière, Proc. U. S. Nat. Mus., **36**, 21, fig. 1, 1909.

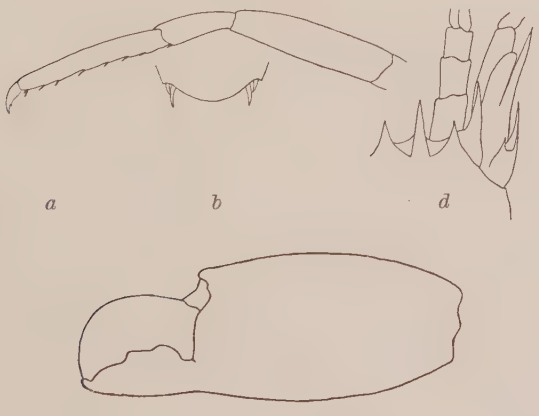


Fig. 54. *Synalpheus lockingtoni; a,* third leg, × about 10; *b,* end of telson, × about 10; *c,* large chela, × about 7½; *d,* frontal margin and right side of antennal region, × about 10.

Characters.—Rostrum a little longer than lateral spines, reaching extremity of basal joint of antennules. Second joint of antennules slightly longer than third; first joint only about one and a-half times longer than second; basal spine reaching at least to middle of the second joint, usually attaining its distal third. Lateral spine of basal joint of antennae about as long or slightly longer than the rostrum; spine of antennal scale about as long as or slightly longer than terminal joint of antennal peduncle. Anterior margin of palm of large chela terminates in a conical tubercle, which is short and always destitute of a spine. Carpus of second pair of legs with first segment slightly shorter than sum of next four; merus shorter than the carpus. Merus of third pair of legs approximately equal to carpus of second pair and about three and three-quarters to four times as wide; dorsal hook of dactyl about twice as long as ventral. Telson with posterior angles right angles not prolonged into a triangular prominence.

Dimensions.—Type, largest female: length 30 mm., carapace 10 mm., larger hand 11 mm. Of largest specimen examined by Coutière: length of carapace and rostral spine 7 mm., of rostral spine about 1 mm., of abdomen 10.2 mm.

Type Locality.—Gulf of California.

Distribution.—Also taken off eastern point of San Nicolas Island, California, 229 to 298 fathoms ("Albatross" station 4421) (Coutière); from Venice Beach, Santa Monica Bay, in roots of *Neriocystis,* and west shore of Catalina Harbor, littoral, received from Venice Marine Biological Station.

Remarks.—In introducing his description, from which the above characters have been drawn in part, Coutière says:

> I believe I have rediscovered the species described by Lockington, although the specimens which represent it differ in slight details. . . . The description of Lockington—very explicit as to the length of the antennal spines, the form of the chela of the first pair, the carpus of the second pair, the dactyl of the third pair, and the telson—appears to permit identification of the specimens of *S. leviusculus* with those which I have studied. The differences bear upon two points: Lockington says the spine of the scaphocerite [antennal scale] does not reach the extremity of the peduncle and that the movable finger of the large chela projects beyond the pollex. The first character hardly exists on the specimens I have seen, the spine being approximately equal to the carpocerite [the terminal joint of the antennal peduncle] and the fingers of the large chela equal.

In turn, the specimens received from the Venice Marine Biological Station which I assign to this species differ slightly from Coutière's figures and descriptions, but his figures differ in a few minor points from the specimens on which they were based. The slender dactyl of the larger chela as figured by him is not so apparent in his specimens. In them the outline approximates more nearly the one figured above; in it, however, the palm is somewhat stouter. Further, the inferodistal angle of the propodus of the third pair of legs bears a pair of juxtaposed spines, both in his specimens and ours, while his figures show but one; similarly, the inferodistal angle of the carpus of the same pair of legs which he figured as unarmed carries a spine in both lots of specimens. The second legs, on the other hand, are in very close agreement. In general the Venice specimens are proportionally somewhat stouter throughout, but structurally they are so nearly like Coutière's that in spite of the great discrepancy in the depths at which they were obtained I feel convinced that they represent the same species (cf. *Crago variabilis, Remarks,* p. 99).

Genus **Betaeus** Dana

Hands inverted so that dactyls are on lower side. Rostrum wanting; front not spined, either emarginate between the eyes or evenly rounded.

Key to the California Species of Betaeus

I. Front emarginate between the eyes. Hands subequal, oval; fingers with but slight gape. (From Point Arena to Laguna Beach.)
harfordi, p. 79.

II. Front rounded. Hands similar, long and narrow; fingers with a more or less wide gape. (Not known north of San Pedro.)
longidactylus, p. 80.

Betaeus harfordi (Kingsley)

Alpheus harfordi Kingsley, Bull. U. S. Geol. Surv., 4, 198, 1878; Bull. Essex. Inst., 14, 124, pl. 2, fig. 4, 1883.
Betaeus aequalis Lockington, Ann. Mag. Nat. Hist. (5), 1, 479, 1878.
Alpheus aequalis Holmes, Occas. Papers Calif. Acad. Sci., 7, 189, pl. 3, fig. 47, 1900.
Betaeus harfordi Rathbun, H. A. E., 10, 108, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., 8, 67, 1916.

a *b* *c*

Fig. 55. *Betaeus harfordi; a*, hand; *b*, dorsal view of anterior portion (after Kingsley); *c*, hand (after Holmes).

Characters.—Front emarginate between the eyes. Hands oval, vertical, smooth, strongly compressed; dactyl slender, the inner margin straight or somewhat concave near the base; fixed finger much wider than the dactyl, the entire inner margin may be straight, or there may be a deep, rounded notch near the base; tips of the fingers curved and crossed when closed; inner margins pubescent, the rest of the hand naked. Basal spine of the antennules long and slender, reaching beyond middle of the second joint of peduncle, second joint about twice the length of the third.

Dimensions.—Types: length 19 and 24 mm., length of carapace 6 and 8 mm., length of larger hand 6 and 8 mm., respectively.

Color.—When fresh dark purple, in alcohol a light flesh tint (Lockington). Pale olive green, eggs translucent green (Hilton).

Type-Locality.—Santa Catalina Island, California.

Distribution.—Point Arena to Laguna Beach, California.

Remarks.—This species lives under the mantle of *Haliotis rufescens* Swains. (Lockington). "... but it is not confined to that habitat, for I found several specimens upon sea-urchins that were brought up from several feet of water at Catalina Island. Their color was a dark purple like the specimens described by

Lockington and resembled the color of the sea-urchins in whose spines they were entangled when captured. At Point Arena I captured from under a rock at low tide a single specimen which was nearly white.'' (Holmes.) Found in kelp holdfasts (Hilton).

Betaeus longidactylus Lockington

Plate 12, figure 2

Betaeus longidactylus Lockington, Proc. Calif. Acad. Sci., **7**, 35, 1877; Ann. Mag. Nat. Hist. (5), **1**, 480, 1878.

Alpheus longidactylus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 190, 1900.

Betaeus longidactylus Rathbun, H. A. E., **10**, 108, 1904; Baker, Rep. Laguna Mar. Lab., **1**, 106, 1912.

Characters.—Front rounded, scarcely notched at the center even rarely. Hands large, oblong, compressed, scabrous, the margins rounded, their length much exceeding that of all the preceding joints combined; fingers slender, widely gaping, longer than the palm, the tips furnished with small, curved, corneous claws, which are crossed when the fingers are closed; fixed finger with a large tooth a little behind the middle of the inner margin and a small, round tooth at the base. Basal spine of the antennules long and slender, about reaching the tip of the second joint of peduncle, second and third joints subequal.

Dimensions.—Type: length 38.4 mm., length of larger hand 14.2 mm., of smaller hand 9.1 mm.

Color.—Color of carapace of dried (type) specimen green, with nuances of russet and olive; fingers of larger hand light red, the tips green (Lockington). The color varies in living specimens from olive green to olive brown; the legs are reddish, and in many specimens there is a light colored dorsal stripe along the middle of the body (Holmes). Blackish, bluish green in life, with whitish stripe on median dorsal line of abdomen, and a white fleck above each of the points of articulation of the epimera; tail-fan of darker color, almost black-green; antennules and antennae brownish green, antennal scale blue with white markings; legs purplish brown with extreme distal portions of propodus and dactylus clear white.

Type Locality.—San Diego, California, on a sandy mud flat, between tides.

Distribution.—San Pedro to San Diego, California.

Remarks.—

The unequal size of the chelipeds (of the type) is exceptional. I have collected numerous specimens of this species at San Pedro, California, where it is found in abundance in tide pools on a rocky ledge near the entrance to the harbor. The hands are similar, generally equal, and very much larger in adult males than in young males and females. The anterior margin of the carapace in some specimens is slightly convex, in others straight, while in a few it is slightly concave. In many adult females, and to a less extent in adult males also, the dorsal surface of the carapace is bulged upward, owing, doubtless, to the enlargement of the ovaries or testes. Many of the specimens were infested with a parasitic isopod attached to the under side of the abdomen (Holmes).

Family Lysmatidae (Processidae)

Rostrum horizontal with dorsal surface of carapace. Mandibles without incisor process and without palp. First pair of legs more or less chelate. Second pair, minutely chelate, slender, with segmented carpus.

Genus **Processa** Leach

One of the first pair of legs chelate and the other simple; rarely both chelate. Second pair of legs unequal, carpus multiarticulate. Rostrum short.

Processa canaliculata Leach

Plate 12, figure 6

Processa canaliculata Leach, Mal. Podoph. Brit., pl. 41 and corresponding text, July 1, 1815; Rathbun, Bull. U. S. Fish Comm., 20, pt. 2, 104, 1900 (1901); H. A. E., 10, 110, 1904.

Characters.—Rostrum slender, about half as long as eye-stalks, unarmed except at apex, which is obscurely bifid and furnished with a few long hairs. First pair of feet rather stout, reaching a little beyond the antennal scale; right, or chelate foot with palm a little longer than carpus or fingers; left or simple foot of first pair with dactylus about one-fourth the length of propodus; remaining feet slender; second pair unequal.

Dimensions.—See *Remarks.*

Type Locality.—Torcross, southern coast of Devon, England.

Distribution.—Europe; Madeira; Bermudas; from North Carolina to Trinidad, including Gulf of Mexico and West Indies; from San Diego, California, to Panama Bay; Japan; Amboina. Shallow water to 111 fathoms (Rathbun).

Remarks.—From Miss Rathbun (1904a, p. 110), I take the following:

Two specimens of unusual interest were taken at San Diego, California, by D. S. Jordan, in 1880. They are about 22 mm. long, and differ from typical specimens in having the left foot of the first pair similar to the right, or chelate. One specimen is a female and has both chelipeds present. The other is so mutilated that the sex is indeterminable; it has a left cheliped, the right is missing. This form might perhaps be deemed a distinct species or genus were it not that among a lot of specimens from Cedar Keys, Florida, both forms occur. From this locality they are small (12 to 15 mm. long), and five specimens are bichelate while four have only a right cheliped, the left foot being simple, as in typical *P. canaliculata.* These two forms from the same locality present no other appreciable difference.

Aside from this remarkable dimorphism in the left first foot the species is a most variable one. The rostrum may be half as long as the eye. The eyes while always of good size are not uniform, in some cases larger and more reniform, with the cornea extending on the outer side almost back to the carapace. The second joint of the antennulae varies from one and one-fourth to twice the length of the third joint. The antennal scale may be a little more than half as long as the carapace (rostrum excluded) or even two-thirds as long as the carapace; it may be just as long as the antennular peduncle or distinctly longer. Of the specimens examined, those from the west coast of Mexico and Panama Bay have the largest eyes; they agree fairly well with the description and figure of Bate's *P. processa* from Amboina, 15 fathoms.

Family Cragonidae (Crangonidae)

(Crangonidae of Authors, not Crangonidae page 73.)

Rostrum generally small, usually dorsally flattened, and not toothed, or wanting; in *Paracrangon* only it is a suberect, elongated, laterally compressed spine. Eyes generally free, in *Nectocrangon* only are they covered by the carapace. Mandibles without incisor and palp. First pair of legs subchelate and stouter than the second. Second pair slender and equal, with unsegmented carpus, either minutely chelate or simple.

Key to the California Genera of the Cragonidae

I. Rostrum present. Eyes free. Dactyls of fourth and fifth pairs of feet long, acuminate, and more or less flattened.

A. Rostrum short, more or less dorsally flattened. All five pairs of legs present.

Crago, p. 82.

B. Rostrum elongate; a laterally compressed, suberect spine. Second pair of legs wanting.

Paracrangon, p. 103.

II. Rostrum wanting. Eyes nearly concealed or hidden by carapace. Dactyls of fourth and fifth pairs of legs dilated, adapted for swimming.

Nectocrangon, p. 102.

Genus **Crago** Lamarck

Rostrum very short and more or less dorsally flattened. Eyes free. Dactyls of fourth and fifth pairs of legs more or less flattened.

Key to the California Species of Crago

I. Gastric region not depressed below general level of the carapace. Antennal scale with very oblique inner margin and narrow extremity; spine exceeding blade except in *C. nigricauda*, in which it is variable, longer or shorter than the blade.

A. Carapace without a median gastric spine.

stylirostris, p. 90.

B. Carapace with one or more median spines.

1. Carapace with one median spine.

a. Sixth segment of abdomen sulcate beneath.

i. Hand of first pair of feet very slender, four or more times as long as wide; dactylus when flexed almost longitudinal. Fifth abdominal segment not carinate.

franciscorum, p. 92.

ii. Hand of first pair of feet not slender, less than three and one-half times as long as wide; anterior margin against which dactylus closes usually more transverse than longitudinal, never forming an angle of less than 45° with lengthwise margin.

a. Fifth segment of abdomen not carinate. Blade of antennal scale having its anterior margin more advanced at inner than at outer angle. Sixth abdominal segment with a large circular spot, characteristic only of this species, on either side at its posterior end.

nigromaculata, p. 86.

b. Fifth segment of abdomen furnished with a superior median carina.

i. Antero-internal angle of antennal scale advanced, reaching nearly as far as or farther than the spine. Hands of first pair of feet little over twice as long as wide; anterior margin against which dactylus closes more nearly transverse than longitudinal.

nigricauda, p. 84.

ii. Antero-internal angle of antennal scale not produced, the spine reaching much beyond the blade. Hands of first pair of feet two and one-half to three times as long as wide; anterior margin, against which dactylus closes, oblique, forming an angle of about 45° with lengthwise margins.

alaskensis elongata, p. 88.

b. Sixth segment of abdomen not sulcate, convex beneath.

i. Hands very stout, only two and one-quarter times as long as wide; anterior margin more longitudinal than transverse. Antepenultimate segment of outer maxillipeds greatly dilated.

alba, p. 89.

ii. Hands elongate, about three times as long as wide, anterior margin more longitudinal than transverse. Antepenultimate segment of outer maxillipeds not dilated. (Not known north of San Pedro.)

holmesi, p. 90.

2. Carapace with two median spines.

a. Rostrum slightly ascending, rounded at the tip; not exceeding the eyes. Abdominal sulci filled with a thin, short pubescence, easily rubbed off. Hands over three times as long as their average width; anterior margin obliquely transverse. Second segment of antennular peduncle twice as long as third. Antennal scale about two-thirds length of carapace.

communis, p. 95.

b. Rostrum ascending at an angle of 45°; tip pointed, usually exceeding the eyes. Abdominal sulci without pubescence. Hands shorter than preceding species, about three times as long as wide; anterior margin more longitudinal.

i. Eyes of moderate size. Second segment of antennular peduncle about three times as long as third. Antennal scale about four-fifths as long as the carapace exclusive of the rostrum. (Not known north of San Francisco.)

resima, p. 96.

ii. Eyes very large. Second segment of antennular peduncle about one and one-half times as long as third. Antennal scale three-fourths as long as the carapace exclusive of the rostrum. (Known only from 685 + fathoms.)

abyssorum, p. 97.

II. Gastric region depressed below general level of the carapace. Antennal scale with spine shorter than the blade, except in *C. variabilis,* in which the spine equals or exceeds the blade, and in *C. lomae,* in which the spine exceeds the blade.

A. Second lateral carina of the carapace (counting from the middle) unarmed.

1. First to fourth abdominal segments, inclusive, smooth.

a. Anterior median spine of the carapace not advanced as far as the line of the orbits. Hands of first pair of legs oblong, narrowing a little distally, or presenting a slight constriction at the base of the spine, three times as long as wide.

munita, p. 98.

b. Anterior median spine projecting in front of the line of the orbits. Hands much as in preceding species, but with anterior margin of hand more longitudinal.
acclivis, p. 98.

2. First to fourth abdominal segments more or less carinated. Hands about three times as long as wide.
a. First to third abdominal segments armed laterally with one or two spines each.
i. First to third segments armed laterally with one spine each; spine of third segment obsolescent in the male. (Known only from 525 + fathoms.)
lomae, p. 100.
ii. First to third segments armed laterally with two spines each. (Not known south of Point Conception.)
spinosissima, p. 100.
b. First to third abdominal segments laterally unarmed. (Known off California only from 158 + fathoms.)
variabilis, p. 99.

B. Second lateral carina of the carapace armed with a spine a little behind the superior lateral spine. First to fourth abdominal segments smooth. Hands of first pair of feet are two and one-half times as long as wide, swollen; the anterior margin more longitudinal than transverse. (Not known south of Laguna Beach.)
munitella, p. 101.

I. Group with gastric region not depressed below the general level of the carapace. Antennal scale with spine exceeding blade except in C. nigricauda, *in which it is variable, usually longer but sometimes shorter than the blade.*

Section a. Carapace with one or no median spines. (*C. stylirostris* is the only species in this section which lacks the median gastric spine, although with a lens one can discern a scabrous granule where the spine usually occurs in the other members of this group.) (For section b, see p. 95.)

Crago nigricauda (Stimpson)

Crangon nigricauda Stimpson, Proc. Calif. Acad. Sci., **1**, 97, 1856; Jour. Boston Soc. Nat. Hist., **6**, 496, pl. 22, fig. 6, 1857; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 170, pl. 2, fig. 31, 1900 (in part); Rathbun, H. A. E., **10**, 112, fig. 50, 1904.

a *b*

Fig. 56. *Crago nigricauda; a,* chela, × 2⅔ (from Rathbun, U. S. N. M.); *b,* acicle (after Holmes).

Characters.—Antennal scale about two-thirds the length of the carapace; antero-internal angle rounded and produced, reaching nearly as far forward as the spine at the outer angle, sometimes farther than the spine. Hands oblong,

a little more than twice as long as wide, with edges subparallel; the margin against which the dactylus closes more nearly transverse than longitudinal. Fifth segment of abdomen with a distinct median carina.

Dimensions.—The specimens taken in San Francisco Bay ranged up to 58 mm. in length from tip of rostrum to end of telson; the greater number averaged between 30 and 35 mm. in length.

Color.—A very dark gray, or blackish, becoming entirely black at the tail. Hands tinted with lilac (Stimpson).

Type Locality.—Tomales Bay, California.

Distribution.—According to Holmes, who includes here *C. alaskensis,* this species ranges from Alaska to Lower California. I have seen specimens only from Comox, British Columbia, southward (Rathbun). Japan (Balss). Littoral to 31 fathoms.

Biological Survey of San Francisco Bay.—Except for *Crago franciscorum, C. nigricauda* is the most abundant and widely distributed species found in the bay and as compared with that species, although taken at seven more dredging stations, was only obtained at about half as many, or 69 out of 137, hydrographic (tow-net) stations.

Crago nigricauda was taken in the upper bay at 82% (18) of dredging and 22% (18) of the hydrographic stations; in the middle bay at 77% (56) of the dredging and 16% (18) of the hydrographic stations; in the lower bay at 50% (19) of the dredging and 31% (33) of the hydrographic stations; and outside at 53% (9) of the dredging stations only.

A summary of these figures indicates that this species, although constituting one of the principal returns of the tow-net, is rather an inhabitant of the lower or bottom strata of water than of the upper layers. It was taken, in all, at three-fourths (75%) of the total number of dredging stations, while it is recorded at less than a fourth (23%) of the total number of hydrographic (tow-net) stations, and of these only seven contained more than ten examples.

With respect to the character of the bottom preferred, little choice is displayed. There seems to be a tendency for the greater number of specimens to frequent the more or less muddy bottoms rather than those of a harder composition, predominantly sand, gravel, or rock; but this indication is possibly the result of using a highly effective piece of apparatus on the former type of bottom and not on the latter, the so-called "sledge trawl" (Sumner, 1914, p. 5, and pl. 8). Of the twenty-seven dredging stations, which returned fifty or more specimens, 74% (20) were made with the sledge trawl.

Although in the bay, i.e., Golden Gate, a considerable number of specimens were taken at stations having a maximum depth of 43 to 53 fathoms (D 5808, 5809) and two possibly at 60 fathoms (D 5738,

23 to 60 fathoms), not a single individual was taken at any station outside at which the depth exceeded 26 fathoms. This is, however, quite in keeping with the *Distribution,* under which the maximum depth for this species is 31 fathoms, recorded in 1897 by the "Albatross" on the Flattery Bank. It is highly probable that the specimens from the deeper bay stations listed above were obtained at or near the shallower end of each of the hauls, for which the minimum depths are 27, 21½, and 23 fathoms, respectively.

In view of its wide distribution within and outside the bay practically all of the temperature and salinity readings observed during the survey (Sumner, 1914) are applicable to this species.

A complete list of stations at which *Crago nigricauda* was taken is given below: D 5700, 5702, 5705, 5707–5709, 5711–5717, 5719–5723, 5727, 5729–5733, 5735–5739, 5742–5751, 5754, 5755, 5757, 5758, 5762–5768, 5770–5774, 5776–5784, 5792–5809, 5815–5830, 5833, 5847–5849; H 4987, 4989, 4994–4996, 4998, 5004, 5013, 5014, 5082–5084, 5091, 5092, 5094, 5098, 5101, 5103–5107, 5109–5118, 5120, 5122, 5124, 5125, 5127, 5138, 5143, 5144, 5146, 5158, 5161, 5163–5165, 5168, 5169, 5172, 5186, 5187, 5193, 5196, 5199, 5250–5252, 5272, 5274, 5276, 5298, 5299, 5303, 5308, 5311, 5319, 5320; "fishing grounds," July, 1912; W. of Blunt Point, Angel Island, March 27, 1913; Fort Baker, April 19, May 13, 1913; Tiburon, April 29, 1913.

Crago nigromaculata (Lockington)

Crangon nigromaculata Lockington, Proc. Calif. Acad. Sci., 7, 34, 1877; Holmes, Occas. Papers Calif. Acad. Sci., 7, 173, pl. 2, fig. 32, 1900; Rathbun, H. A. E., 10, 114, fig. 51, 1904.

a *b*

Fig. 57. *Crago nigromaculata; a,* chela, ♀, × 2⅔ (after Rathbun, U. S. N. M.); *b,* acicle (after Holmes).

Characters.—Sixth segment of abdomen with a large circular spot on either side of its posterior end; bluish in life and when fresh. Hands similar to but a little longer than those of *C. nigricauda.* Antennal scale also like that of

C. nigricauda, but longer and narrower; blade with anterior margin more advanced at inner than at outer angle. Fifth segment of abdomen not carinate.

Dimensions.—Type: from tip of antennal scale to tip of tail 63.5 mm., of body from tip of rostrum 52.3 mm. The largest specimen taken in San Francisco Bay, an ovigerous female, measured 69 mm. from tip of rostrum to end of telson; the general average was between 40 and 45 mm.

Color.—Readily distinguished from all others by the black spot on each side of the tail (Lockington).

Type Locality.—San Diego, California, 6 fathoms.

Distribution.—From northern California to Lower California, 3 to 33 fathoms (Rathbun).

Biological Survey of San Francisco Bay.—Crago nigromaculata is a bottom-dwelling form, rather scatteringly distributed in the middle and upper lower bay, and outside within the 30-fathom curve. With few exceptions all our specimens were taken on a muddy sand, sandy mud, or mud bottom, in 5 to 16 fathoms by means of the sledge trawl. Not a single specimen was taken in any of the tow-net hauls.

In the middle bay out of a return of seventy-eight specimens from thirteen stations (18% of the total number) only four hauls of one specimen each were not made with the sledge trawl (D 5705, 5-foot Tanner trawl; D 5778 and 5779, 19-inch boat dredge and 3-foot Tanner trawl, and D 5795, oyster dredge), and only three (D 5778, 5779, 5795 included in the four just mentioned) had a bottom of sand and stones or boulders. These three were also the only middle bay records not made in the upper and eastern portions of that division. Eighteen specimens, all told, were obtained in two seine hauls on the Fort Baker Beach.

In the lower bay fourteen specimens were taken at three stations (D 5803–5805; 8% of the total number), all of which were made with the sledge trawl off Hunter's Point, on a soft mud bottom containing worm tubes in two instances (D 5804, 5805).

Outside at three stations (D 5736, 5792, 5806, 17% of the total number), made with the 9 and 12-foot beam trawls in 9 to 26 fathoms, on a fine gray to greenish sand bottom, twenty specimens were obtained.

The ranges of temperature and salinity correlated with the stations from which this species is recorded are, respectively, 8.8° to 17.2°C, and 27.8 to 34.1.

The middle bay stations at which *Crago nigromaculata* was taken are: D 5705, 5778, 5779, 5795, 5797, 5799, 5821, 5823–5826, 5828, 5830; Fort Baker, April 19 and May 13, 1913.

Crago alaskensis elongata (Rathbun)

Crangon alaskensis elongata Rathbun, Proc. U. S. Nat. Mus., 24, 888, 1902; H. A. E., 10, 115, fig. 54, 1904.

a *b*

Fig. 58. *Crago alaskensis elongata*, ♀; *a*, acicle, × 2; *b*, anterior portion of carapace, × 2½ (from Rathbun, U. S. N. M.).

Characters.—Antennal scale as long as the carapace, exclusive of the rostrum; antero-internal angle of blade rounded and not produced; spine extending considerably beyond the blade. Hands from two and a half to three times as long as wide; anterior margin, against which dactylus closes obliquely forming an angle of about 45° with the lengthwise margin. Fifth segment of abdomen with superior median carina.

Dimensions.—Type, ovigerous female: length from tip of rostrum to tip of telson 55.7 mm., length of carapace, 13.5 mm., of antennal scale 11.6 mm. The San Francisco Bay material ranged in length, from tip of rostrum to end of telson, for the smallest specimen, a male, 11 mm., to 55 mm. for the largest, an ovigerous female; the greater number of the specimens averaged about 44 mm. in length.

Type Locality.—Off Santa Barbara, California, 29 fathoms ("Albatross" stations 2970, 2971).

Distribution.—British Columbia to United States Mexican boundary line.

Remarks.—This subspecies is a form of *C. alaskensis*, which is found from Puget Sound northward. It differs from the typical *C. alaskensis* in that the rostrum is longer and narrower; the outer flagellum of the antennules falls considerably short of the antennal scale; the antennal scale is much longer, about equaling the length of the carapace exclusive of the rostrum.

Biological Survey of San Francisco Bay.—Crago alaskensis elongata was taken in numbers of twenty or more at all outside stations at which the depth exceeded 19 fathoms, D 5785–5792 except D 5788, 60 to 68 fathoms, where only two specimens were obtained. *Pandalus jordani* was taken at all but the most shoal of these stations, D 5792. 19 to 26 fathoms, the others being all over 29 fathoms in depth. The bottom uniformly was very fine green sand except at D 5791, where little else than refuse and garbage was brought up. For these stations the observed temperature and salinity ranges are respectively 9.3° to 12.2° C, and 33.8 to 34.3.

Crago alba (Holmes)

Crangon alba Holmes, Occas. Papers Calif. Acad. Sci., **7**, 174, 1900; Rathbun, H. A. E., **10**, 117, figs. 56, 57, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., **10**, 54, 1918.

a *b* *c*

Fig. 59. *Crago alba*, ♀; *a*, acicle, × 2; *b*, dorsal view of orbital region of carapace, × 4; *c*, chela, × 2⅔ (from Rathbun, U. S. N. M.).

Characters.—Sixth segment of abdomen rounded beneath, not grooved. Third maxillipeds reaching the end of the blade; antepenultimate segment much expanded. Hands very stout, only two and one-fourth times as long as the width measured from the inner base of the immovable spine; the anterior margin is more longitudinal than transverse. Antennal scale about three-fourths the length of the carapace; blade with very oblique inner margin, the tip scarcely wider than the adjacent portion of the spine; spine extending considerably beyond the blade.

Dimensions.—The specimens taken in connection with the Survey ranged from 32 to 45 mm. in length, the average being about 36 mm. in length, from tip of rostrum to end of telson.

Color.—Nearly white (Holmes). White dotted with black (Hilton).

Type Locality.—Monterey Bay, California.

Distribution.—From Vancouver Island, British Columbia, to San Diego, California, to a depth of 47 fathoms (Rathbun).

Biological Survey of San Francisco Bay.—Crago alba was dredged only once in the course of the survey, eight specimens at D 5790, outside, in 33 to 35 fathoms; bottom very coarse, variegated sand, with a small proportion of fine sand; temperature 9.7° to 11.5° C; salinity 33.9. Over fifty specimens of *Crago alaskensis elongata* were also taken at this station.

Crago holmesi (Rathbun)

Crangon holmesi Rathbun, Proc. U. S. Nat. Mus., **24**, 888, 1902; H. A. E., **10**, 118, fig. 58, 1904.

a *b* *c*

Fig. 60. *Crago holmesi*, ♀; *a*, acicle, × 4; *b*, dorsal view of rostral region of carapace, × 8; *c*, chela, × 8 (from Rathbun, U. S. N. M.).

Characters.—Sixth segment of abdomen rounded beneath, not grooved. Third maxillipeds exceeding the antennal scale a little; antepenultimate segment not dilated. Hands elongate, about three times as long as wide; the anterior margin against which the dactyl folds is more longitudinal than transverse. Antennal scale either as long as or nearly as long as the carapace, exclusive of the rostrum; blade very narrow at the extremity; spine much exceeding blade.

Dimensions.—Type, ovigerous female: length 23 mm., length of carapace 5.3 mm., of antennal scale 4.2 mm.

Type Locality.—Wilmington, California, 27 fathoms ("Albatross" station 2939).

Distribution.—From San Pedro and Santa Catalina Island, California, to Cerros Island, Lower California, 15 to 58 fathoms.

Crago stylirostris (Holmes)

Crangon stylirostris Holmes, Occas. Papers Calif. Acad. Sci., **7**, 174, pl. 2, figs. 33–35, 1900; Rathbun, H. A. E., **10**, 118, fig. 59, 1904.

a *b* *c*

Fig. 61. *Crago stylirostris; a*, chela; *b*, dorsal view of anterior portion of carapace; *c*, acicle (after Holmes).

Characters.—Carapace without a median gastric spine. Rostrum long, narrow, grooved above, tapering to a narrow, acute tip, which is curved strongly downward and much compressed laterally. Sixth segment of abdomen not sulcated

below. Third maxillipeds with antepenultimate segment outwardly dilated, as in *C. alba*. Hands slightly widened distally, shorter and broader than in *C. alba*, the length being barely twice the width; anterior margin more transverse than longitudinal. Antennal scale shaped as in *C. alba* but much shorter, being only a little over half as long as the carapace.

Dimensions.—Type: length 55 mm.; length of carapace 15 mm., of antennal scale 10 mm. The Bay specimens range up to 54 mm. in length, the largest taken an ovigerous female; the general average is between 34 and 47 mm.

Type Locality.—Trinidad, Humboldt County, California.

Distribution.—Chirikof Island, Alaska, to Santa Cruz, California, to a depth of 26 fathoms.

Biological Survey of San Francisco Bay.—Crago stylirostris is primarily a bottom-dweller, living on a more or less hard, sand or sandy bottom, occurring principally in that portion of the middle bay lying west of Alcatraz, Angel Island, and the head of Raccoon Strait, exclusive of Richardson Bay (see plate 7), as well as outside, where, however, it was not found beyond the 26 fathom line. *Crago stylirostris* was taken at only three hydrographic stations (H 4996 middle bay; H 5005, 5015 lower bay, only one specimen at each).

In the upper bay this species was taken at but 9% (2) of the dredging stations at the extreme lower end between Points San Pedro and San Pablo; in the middle bay at 38% (28) of the stations, of which 75% (21) were in the western section defined above, inclusive of Golden Gate; in the lower bay at only 5% (2); and outside at 47% (8) of the stations. Of the eleven eastern middle, upper, and lower bay stations, only 9% (1) returned more than eleven specimens and then only a total of thirty-three, while on the other hand not less than 47% (17) of the thirty-six western middle bay and outside stations returned more than twelve, 22% (8) returned more than thirty-three specimens. At five (62%) of these eight stations, fifty and more specimens were obtained.

With respect to the character of the bottom as stated above, we find that thirty-one (77%) of the stations at which *Crago stylirostris* was dredged had a more or less hard, predominantly sandy bottom, of which eighteen (58%) were purely sand bottoms, while thirteen (42%) contained a considerable admixture of gravel, rock, or stones; six (15%) of the stations were made on a muddy sand or sandy mud bottom; and only two (5%) on a purely mud bottom; the bottom at one (2%) of the stations was not characterized.

The extremes of temperature and salinity to which the distribution of this species subjects it, ranged, respectively, from 8.7° to 16° C, and from 17.5 to 34.1.

A complete list of stations at which *Crago stylirostris* was taken includes: D 5700, 5702, 5707, 5708, 5710–5713, 5715, 5729, 5731–5733, 5735–5737, 5741, 5742, 5745, 5746, 5765, 5769, 5776–5778, 5792, 5795, 5796, 5798–5802, 5806–5809, 5820, 5826, 5828, 5829; H 4996, 5005, 5015; "fishing grounds," July, 1912; west of Blunt Point, Angel Island, March 27, 1913.

Crago franciscorum (Stimpson)

Crangon franciscorum Stimpson, Proc. Calif. Acad. Sci., **1**, 97, 1859; Jour. Boston Soc. Nat. Hist., **6**, 495, pl. 22, fig. 5, 1857; Rathbun, R., The Fisheries and Fishery Industries of the U. S., sec. 1, p. 818, 1884; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 172, 1900; Rathbun, H. A. E., **10**, 120, fig. 61, 1904.

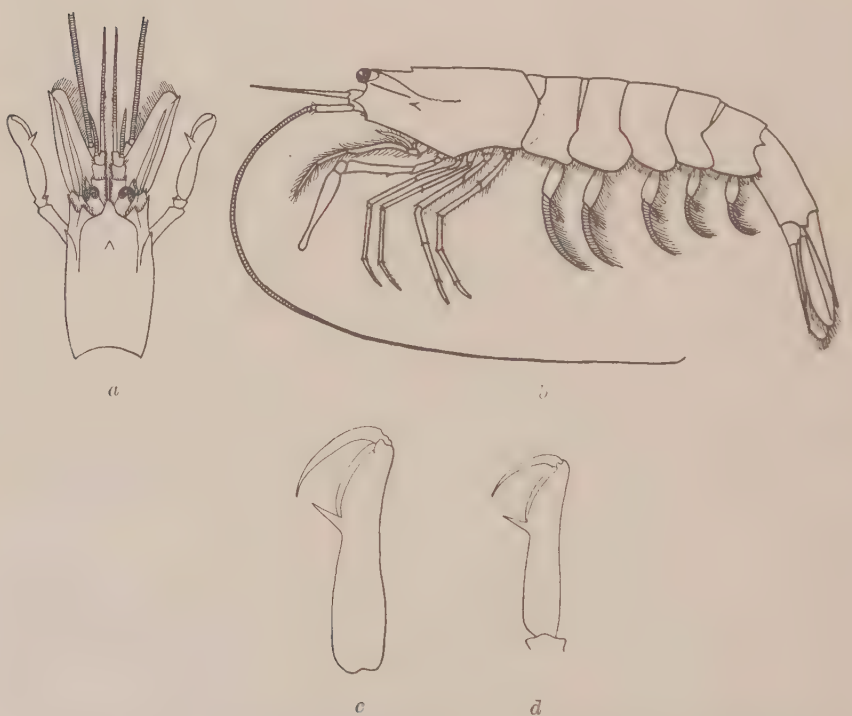


Fig. 62. *Crago franciscorum*, ♀, natural size; *a*, dorsal view of anterior portion; *b*, lateral view; *c*, chela of ♂, × 2½; *d*, chela of ♀, × 2½ (last two from Rathbun, U. S. N. M.).

Characters.—Hands very long and narrow from four to four and a half times longer than wide (longer in the male than in the female), inflated near the base, outer margin concave for most part, inner convex, dactyl when flexed, almost longitudinal. Antennal scale about three-fourths as long as carapace, blade

broad and slightly rounded at extremity, spine exceeding blade. Fifth segment of abdomen not carinate.

Dimensions.—Type: about 76.2 mm. The Bay specimens ranged up to 82 mm. in length from tip of rostrum to end of telson for the largest female; the average for the greater number of specimens taken is between 47 and 62 mm.

Color.—Dark and light yellowish gray mottled. Eyes salmon-colored in life (Stimpson).

Type Locality.—San Francisco Bay, California.

Distribution.—Southeastern Alaska to San Diego, California, to a depth of 29 fathoms.

Biological Survey of San Francisco Bay.—Crago franciscorum is universally distributed throughout the bay, extending well up into Suisun Bay, from which it is the only decapod recorded, down into the lower bay as far as suitable collecting apparatus was employed (D 5847, south of which only oyster tongs were used), and outside to the fourteen fathom line.

It was taken in the upper bay at twenty (91%) of the dredging and thirty-five (44%) of the hydrographic stations; in the middle bay at fifty-one (70%) of the dredging and thirty-three (30%) of the hydrographic stations; in the lower bay at fifteen (39%) of the dredging and sixty-nine (64%) of the hydrographic stations; and outside at eight (47%) of the dredging stations, only.

Although taken at seven less dredging stations than *Crago nigricauda,* as compared with that species *Crago franciscorum* is preponderantly an inhabitant of the upper water layers, being an abundant and oft recurring catch of the tow-net. It was taken, in all, at one hundred and thirty-seven (45%) of the total number of hydrographic stations, of which eighty-six (63%) returned more than ten specimens each.

As Stimpson remarked, this species "is found very abundantly in sandy coves around the Bay." We found it even more abundant in the more or less muddy regions of the bay, principally in the upper, lower, and the eastern and upper portions of the middle bay as can readily be seen in a review of the tow-net hauls. These were all made with the same gear, at approximately the same depth and are therefore fairly comparable. From these hydrographic (tow-net) stations, fifty or more specimens were taken at fourteen (40%) of the upper bay stations; at nineteen (28%) of the lower bay stations; and at only six (18%) of the middle bay stations, all of which were in the upper and eastern portions, lying east of Alcatraz, and east and north of Angel Island. No specimens were taken in the tow-net outside.

Somewhat similar relations are shown between the dredge hauls in the various divisions of the bay, but they are much less reliable owing to employment of several different types of collecting apparatus, i.e., boat dredge, beam trawl, sledge trawl, and bucket dredge. Considering only the dredging stations, fifty or more specimens were returned by nine (45%) of the upper bay stations; by eight (53%) of the lower bay stations; by fourteen (27%) of the middle bay stations, of which all but one (93%) are in the upper and eastern portions; and by three (37%) of the outside stations.

At only two of the dredging stations did the depth exceed 19 fathoms: D 5742 in Raccoon Strait, 20 to 30 fathoms (thirty-five specimens); and D 5808 in Golden Gate, 27 to 43 fathoms (two specimens). Outside, however, no specimens were taken at a depth exceeding 14 fathoms.

The ranges of temperature and salinity as observed for the entire bay, as in the case of *Crago nigricauda,* are applicable to this species also; but it must be remembered that the occurrence of *Crago franciscorum* in Napa Creek, above Mare Island, as well as in Suisun Bay, indicates a range of salinity much below any recorded during the survey. Unfortunately we are unable to cite this range here as no hydrographic observations were made above Carquinez Strait.

The list of stations at which *Crago franciscorum* was taken includes: D 5700, 5702, 5705–5716, 5719–5721, 5723, 5725, 5726, 5729–5733, 5735–5737, 5739, 5741–5761, 5763, 5764, 5766–5768, 5771–5773, 5777, 5779, 5780, 5784, 5793–5800, 5802–5808, 5815–5828, 5830, 5847, 5848; H 4986, 4987, 4989, 4993–4996, 4998, 4999, 5002–5008, 5010, 5012–5017, 5082–5096, 5098, 5101–5107, 5109–5117, 5120, 5122–5128, 5131, 5134, 5137, 5138, 5143, 5144, 5146, 5149, 5150, 5155, 5156, 5158–5169, 5171–5173, 5176, 5178–5183, 5185–5188, 5190, 5193, 5196, 5199, 5200, 5218, 5228, 5250–5255, 5257, 5262, 5266, 5267, 5269–5276, 5288, 5298, 5299, 5302, 5306, 5308, 5311, 5313, 5315, 5316, 5319, 5320, 5330; North of Key Route pier, August 2, 1912; Fort Baker, April 19, 1913; Tiburon, April 29, 1913; electric light, ship's side, Sausalito, April 3, 1913.

I. Group with gastric region not depressed below the general level of the carapace. Antennal scale with spine exceeding blade—(Continued)

Section b. Carapace with two median spines. (For section a, see p. 84.)

Crago communis (Rathbun)

Crangon communis Rathbun, The Fur Seals and Fur-Seal Islands of the North Pacific Ocean, pt. 3, p. 556, 1899; H. A. E., 10, 123, fig. 64, 1904.

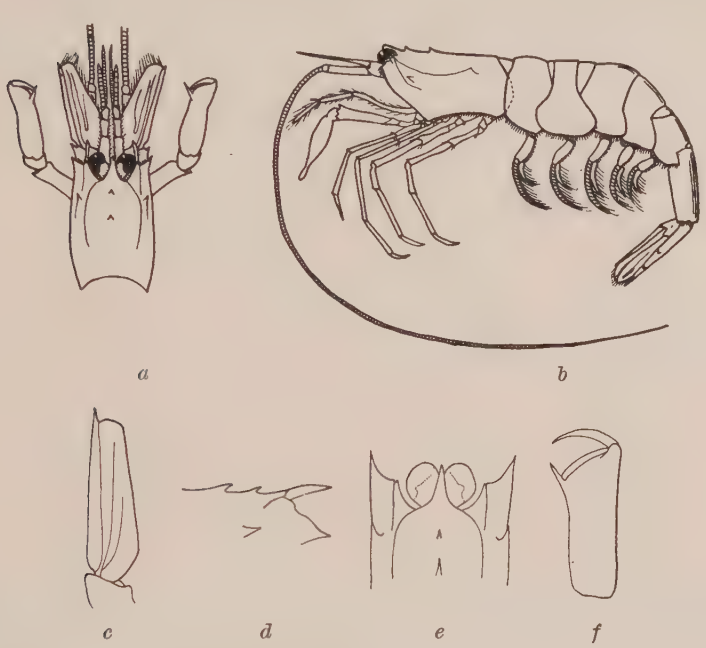


Fig. 63. *Crago communis*, ♀; *a*, dorsal view of anterior portion, natural size; *b*, lateral view, natural size; *c*, acicle, × 2; *d*, lateral view of anterior portion of carapace; *e*, dorsal view of same, × 2; *f*, chela, × 2½ (last four from Rathbun, U. S. N. M.).

Characters.—Third to fifth abdominal segments with a blunt median carina; first and second segments with a transverse sulcus; the third and fourth each with two transverse sulci, which are connected either side of the median carina; sixth segment furnished with two prominent longitudinal carinae, a median sulcus, and a sulcus on the outer side of each carina; the telson with a deep median sulcus. The abdominal sulci are filled with a short, thin pubescence, easily rubbed off. Second segment of antennular peduncle about twice as long as the third. Rostrum slender, tapering, ascending, having a median sulcus, tip rounded, not extending beyond the eyes. Hands over three times as long as their average width, anterior margin obliquely transverse. Antennal scale about two-thirds the length of the carapace; spine exceeding blade.

Dimensions.—Type, female: length 64 mm., length of carapace 16 mm., length of antennal scale 10.5 mm. The Survey specimens ranged between 33 and 65 mm. in length; the average of the twenty-five specimens taken being about 40 mm.

Type Locality.—Off Pribilof Islands, Bering Sea, 51 fathoms ("Albatross" station 3441).

Distribution.—Bering Sea to San Diego, California, 9 to 309 fathoms.

Remarks.—The rostrum in normal individuals does not extend beyond the eyes; in many cases, however, it is evident that the rostrum has been broken off or injured and later renewed, the new rostrum having a narrow, elongated, and ascending tip, exceeding the eyes but of variable length. In other respects these abnormal forms do not differ from the types (Rathbun).

Biological Survey of San Francisco Bay.—Crago communis was taken only at the most distant as well as the deepest of the outside stations, D 5788; twenty-five specimens in 60 to 68 fathoms; temperature 9.3° to 11.3° C; salinity 34.0 to 34.2. *Crago resima* also was recorded from this station only; both *C. alaskensis elongata* and *C. spinosissima* were also taken here.

Crago resima (Rathbun)

Crangon resima Rathbun, Proc. U. S. Nat. Mus., 24, 889, 1902; H. A. E., 10, 124, fig. 65, 1904.

Fig. 64. *Crago resima*, ♀; *a*, acicle, × 3½; *b*, lateral view of anterior portion of carapace, × 2½; *c*, dorsal view of same, × 2; *d*, chela, × 4 (from Rathbun, U. S. N. M.).

Characters.—The first five abdominal segments are smooth, the first and second segments have a thickened band along the posterior margin, in front of which there is a slight transverse depression; the fifth segment has an obscure median carina, with a short depression on either side at the anterior end; the sixth segment has two prominent carinae and a corresponding median depression; the telson has a slight median sulcus. Eyes of moderate size. Second segment of antennular peduncle three times as long as the third. Rostrum long, narrow, pointed, advanced beyond the eyes, ascending at an angle of about forty-five degrees, slightly curved, and prolonged downward in a thin, compressed plate, which appears spatulate in a side view. The development of this plate is dependent on age; specimens 20 mm. long show no evidence of it. Hands shorter than in *C. communis*, about three times as long as wide, anterior margin also more longitudinal than in *C. communis*. Antennal scale about four-fifths the length of the carapace exclusive of the rostrum, spine exceeding blade.

Dimensions.—Type, ovigerous female: length 48.3 mm., length of carapace 12.2 mm., of antennal scale 8.2 mm. The three specimens taken in connection with the Survey averaged 38.5 mm. in length from tip of rostrum to end of telson.

Type Locality.—Off San Diego, California, 124 fathoms (''Albatross'' station 2935).

Distribution.—From off San Francisco, California, to San Domingo Point, Lower California, 15 to 266 fathoms.

Biological Survey of San Francisco Bay.—Three specimens of *Crago resima* were taken at D 5788, associated with *Crago communis, C. alaskensis elongata* and *C. spinosissima* (see *C. communis,* above).

Crago abyssorum (Rathbun)

Crangon abyssorum Rathbun, Proc. U. S. Nat. Mus., 24, 890, 1902; H. A. E., 10, 125, fig. 66, 1904.

a *b* *c* *d*

Fig. 65. *Crago abyssorum,* ♀; *a,* antennal scale, × 2; *b,* lateral view of rostrum and dorsal spines, × 2; *c,* dorsal view of anterior part of carapace, × 2; *d,* chela, × 3¾.

Characters.—The fifth abdominal segment has a long, blunt carina; the sixth has two prominent dorsal carinae and a low lateral carina on each side near the dorsal, but extending only half the length of the segment; the telson has a median furrow on its anterior fourth. Eyes very large, hemispherical, their inner faces flat and contiguous; cornea covering nearly all the outer face. Second segment of antennular peduncle about one and a half times as long as the third. Rostrum linear, flattened above, acute, ascending at an angle of about thirty degrees with the carapace, and slightly curved, a little higher than wide, the lower part laterally compressed; length about one-fourth the remainder of the carapace. Hands widening a little distally, their length three times the width, measured at the inner base of the spine; the dactylus is more longitudinal than transverse. The antennae have a slender spine at the outer base of the scale, which is narrow-oblong and three-fourths as long as the carapace, rostrum excluded.

Dimensions.—Type, female: length 61 mm., of carapace and rostrum 17 mm., of carapace, exclusive of rostrum, 13.5 mm., of antennal scale 10.3 mm.

Type Locality.—Bering Sea, southwest of Pribilof Islands, 1771 fathoms (''Albatross'' station 3603).

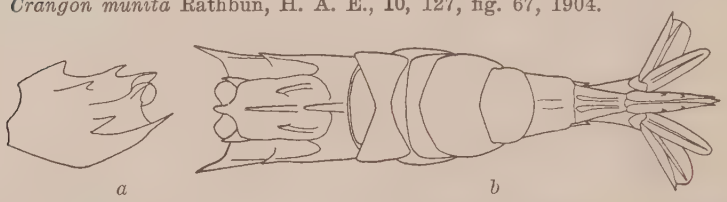
Distribution.—Bering Sea to the southern extremity of California, 685 to 1771 fathoms (Rathbun).

II. Group with gastric region depressed below the general level of the carapace. Antennal scale with the blade exceeding the spine, except in C. variabilis, *in which the spine equals or exceeds the blade, and in* C. lomae, *in which the spine exceeds the blade. (The second lateral carina of the carapace counting from the middle, is unarmed in all the species in this group except* C. munitella, *in which it is armed with a spine situated a little behind the superior lateral spine.)*

Crago munita (Dana)

Crangon munitus Dana, Crust. U. S. Expl. Exped., **1**, 536, 1852, pl. 33, fig. 5, 1855.

Crangon munita Rathbun, H. A. E., **10**, 127, fig. 67, 1904.



a *b*

Fig. 66. *Crago munita*, ♂, × 2; *a*, lateral view of carapace; *b*, dorsal view of carapace and abdomen (from Rathbun, U. S. N. M.).

Characters.—First to fourth abdominal segments inclusive, smooth. Carapace less than two-fifths the length of the abdomen; anterior median spine of the carapace not advanced as far as the line of the orbits. Rostrum short, reaching to a line between the tips of the orbital and the anterolateral spines, nearly horizontal, medially sulcate, tip rounded. Hands oblong, narrowing a little distally or presenting a slight constriction at the base of the spine, three times as long as wide.

Dimensions.—Type: length of body 46.6 mm., of carapace 12.7 mm.

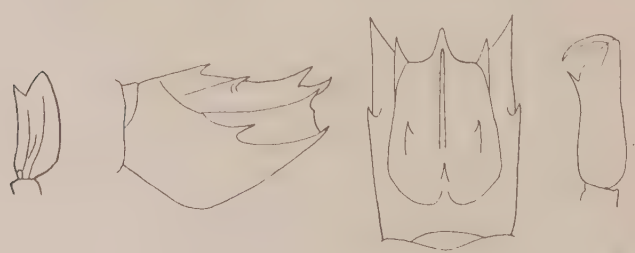
Type Locality.—Puget Sound.

Distribution.—Port Etches, Alaska, to San Miguel Island, California, 12 to 114 fathoms.

Remarks.—Dana described the abdomen as smooth. The carina of the fifth segment is very indistinct in the female, while Dana in his figure indicates two carinae on the sixth segment (Rathbun).

Crago acclivis (Rathbun)

Crangon acclivis Rathbun, Proc. U. S. Nat. Mus., **24**, 890, 1902; H. A. E., **10**, 129, fig. 68, 1904.



a *b* *c* *d*

Fig. 67. *Crago acclivis; a*, acicle, ♀, × 8; *b*, lateral view of carapace, ♂, × 3½; *c*, dorsal view of carapace, ♂, × 4; *d*, chela, ♀, × 8 (from Rathbun, U. S. N. M.).

Characters.—First to fourth abdominal segments, inclusive, smooth. Anterior median spine of the carapace projecting in front of the line of the orbits. Rostrum narrower than in *C. munita,* and ascending at an angle of about forty-five degrees. Hands much as in *C. munita,* but with anterior margin of hand more longitudinal.

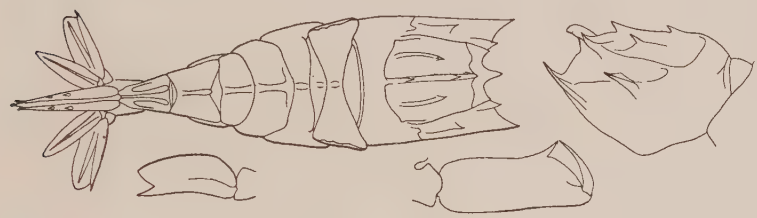
Dimensions.—Type, male: length 24.8 mm., length of carapace 7.4 mm., of scale 3 mm.

Type Locality.—Off Santa Cruz Island, California, 266 fathoms ("Albatross" station 2948).

Distribution.—Also off Trinity Islands, Alaska, 159 fathoms; Santa Catalina Island, California, 80 fathoms; southwest of San Nicolas Island, California, 158 fathoms. One specimen taken at each locality (Rathbun).

Crago variabilis (Rathbun)

Crangon variabilis Rathbun, Proc. U. S. Nat. Mus., 24, 890, 1902; H. A. E., 10, 129, fig. 69, 1904.



a *b* *d* *c*

Fig. 68. *Crago variabilis,* ♀; *a,* antennal scale, × 4; *b,* dorsal view of carapace and abdomen, × 2; *c,* lateral view of carapace, × 2; *d,* chela, × 4 (from Rathbur, U. S. N. M.).

Characters.—Second, third, fourth, and fifth (sometimes the first) abdominal segments carinated, and except on the first two the carina is usually high, laterally compressed, and blunt. Carapace much as in *C. munita,* but nearly half as long as the abdomen. Rostrum short, convex from behind forward, the tip rounded and thickened. Hands vary from two and a half to three times as long as wide.

Dimensions.—Type, female: length 32.2 mm., length of carapace 9.2 mm., of hand 5.6 mm.; width of hand 2 mm. Of male, also measured by Miss Rathbun: length 24.6 mm., length of carapace 7 mm., of hand 4.1 mm.; width of hand 1.5 mm.

Type Locality.—Off North Head, Akutan Island, Alaska, 72 fathoms ("Albatross" station 2842).

Distribution.—Bering Sea, Alaska Peninsula, and Aleutian Islands; California (southwest of San Nicolas Island, 158 fathoms); 50 to 695 fathoms (Rathbun).

Remarks.—Miss Rathbun remarks:

There is more variation in this species than is usual in this genus, perhaps owing to the great bathymetrical range.

The rostrum is often much thickened and elevated, the median sulcus being almost obliterated.

The hand is not of uniform proportion. It is longer in the male than in the female, and varies in specimens of the same sex from different localities. The median abdominal carina is in general less strong on specimens from deeper water.

These differences are not sufficiently constant to warrant the division of the species.

Crago spinosissima (Rathbun)

Crangon spinosissima Rathbun, Proc. U. S. Nat. Mus., **24**, 891, 1902; H. A. E., 10, 130, fig. 70, 1904.

a *b*

Fig. 69. *Crago spinosissima*, ♀, × 2; *a*, dorsal view of carapace; *b*, lateral view of carapace and abdomen (from Rathbun, U. S. N. M.).

Characters.—First to fourth abdominal segments more or less carinated. Anterior median spine of the carapace reaching forward to a line in front of the rear line of the orbits. Rostrum narrow and acute, ascending at an angle equal to that of the spine directly behind it. Hands about three times as long as wide. This species differs from all allied species in having the first to third abdominal segments, inclusive, armed laterally with two spines each.

Dimensions.—Type, female: length 36 mm., length of carapace 10.5 mm. The Survey specimens range between 28 and 48 mm. in length from tip of rostrum to end of telson.

Type Locality.—Off Point Arena, California, 51 fathoms ("Albatross" station 3351).

Distribution.—Off Oregon and California, 15 to 96 fathoms. So far as known Point Fermin is the southern limit of this species. I have seen specimens collected there by the Venice Marine Biological Station, at a depth of about 15 fathoms.

Biological Survey of San Francisco Bay.—Crago spinosissima was taken at two of the outside stations: two specimens at D 5788, 60 to 68 fathoms, and three specimens at D 5789, 33 to 46 fathoms. The bottom of both stations was "fine, green sand"; the temperature range was 9.3° to 11.4° C; and that of the salinity 33.8 to 34.3. At the deeper of these stations, D 5788, at which, in fact, the greatest depth recorded in the course of the survey, 68 fathoms, was attained, the species in question was found associated with both *C. communis* and *C. resima*, as well as *C. alaskensis elongata*.

Crago lomae, sp. nov.

Plate 12, figures 3 and 4

Description.—Near *C. spinosissima*, with spines of carapace similarly placed, anterior median spine equaling or exceeding rostrum in prominence, more acutely pointed, and more nearly erect, at an angle of about sixty-five degrees with the carapace, while the rostrum meets the carapace at an angle nearer forty-five degrees; midway between anterior and posterior spine there is a small denticle on the median carina; surface of the carapace is roughened with minute

granulations. Antennal scale with spine noticeably exceeding blade and separated from it by a deep incision for about the distal fourth of its length. First two abdominal segments obsolescently carinate dorsally, third carinate on anterior half, fourth on anterior two-thirds, and fifth throughout its length; sixth abdominal segment with a median sulcus formed by two nearly parallel carinae, diverging somewhat anteriorly; these carina are paralleled on each side by another carina which anteriorly diverges even more from the median line; abdominal segments one and two are each armed laterally with a single spine, while the third segment has a subacute downward projection near the anterolateral angle; in the male this projection is obsolescent or entirely lacking; fourth and fifth segments with posterolateral angle acute. Telson exceeding inner branch of uropods, which in turn exceeds the outer branch; tip acute and armed in the male with three pairs of lateral spinules and in the female with four.

Ventrally the thoracic sternum of the male has an anteriorly directed spine between the bases of the second pair of legs, and a thin, laterally compressed keel between the bases of the following three pairs of legs. In the female there is a low, blunt tubercle between the bases of the second pair of legs. The first, second, and third abdominal segments of the male are armed below with a prominent, acute median spine; the fourth has a less prominent blunt spine; and the fifth has only a low tubercle; the sixth segment is ventrally unarmed. The abdomen of the female ventrally unarmed except for a small obsolescent tubercle between the pleopods of fifth segment.

Dimensions.—Type male, holotype (Cat. No. 52714, U. S. N. M.): length from tip of rostrum to end of telson 35 mm., length of carapace and rostrum 11 mm., of hand about 6 mm.; of female, total length 44 mm., of carapace and rostrum 13 mm., of hand 7 mm.

Type Locality.—Off Point Loma, California, 525 to 541 fathoms, 1 male (''Albatross'' station 4334).

Distribution.—The only other specimen of this species, a female, was also taken off Point Loma, 628 to 640 fathoms (''Albatross'' station 4353).

Remarks.—In this species the tip of the rostral spine reaches only about to the middle of the ocular peduncle; in *C. spinosissima* it reaches to the cornea but does not exceed it; and in *C. spinirostris* (Rathbun, 1904*a*, p. 131), another closely related species, the tip of the rostral spine exceeds the eyes.

Crago munitella (Walker)

Crangon munitellus Walker, Trans. Liverpool Biol. Soc., **12**, 275, pl. 16, fig. 1, 1898; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 176, 1900.
Crangon munitella Rathbun, H. A. E., **10**, 132, 1904.
Crago munitella Hilton, Jour. Ent. Zool., Pomona Coll., **10**, 54, 1918.

Fig. 70. *Crago munitella*, ♀, dorsal view of carapace and abdomen, × 1⅝ (adapted from Walker).

Characters.—Second lateral carina of the carapace (counting from the middle) armed with a spine a little behind the superior lateral spine. First to fourth abdominal segments smooth. Hands two and one-half times as long as wide, swollen, the anterior margin more longitudinal than transverse.

Dimensions.—Type, ovigerous female: length 25 mm.

Color.—Abdomen with sixth segment darker colored than the others; a dark transverse band on the caudal appendages (Walker). One specimen was mottled brown with bright red markings along the back; the whole body of another was a dark slate color; another was banded with slate color, with center of body red; and still another had bands of slate and red alternating (Hilton).

Type Locality.—Puget Sound.

Distribution.—Puget Sound to Laguna Beach and Santa Catalina Island, California, 3½ to 40 fathoms.

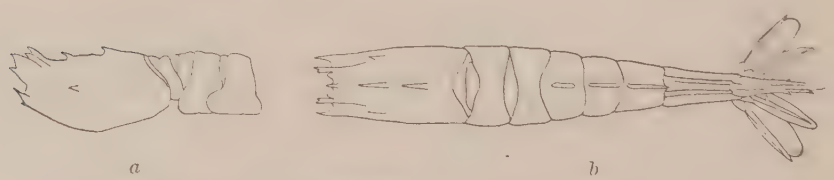
Biological Survey of San Francisco Bay.—Crago munitella was dredged in 3½ to 7 fathoms, from a bottom consisting of angular rock fragments of various sizes, at two adjacent stations, D 5773 and 5775, on each side of Yellow Bluff, south of Sausalito. At the latter station, *C. munitella* was in company with *Scleroplax granulata,* while at the former it was associated with *Spirontocaris cristata, Crago nigricauda, C. franciscorum,* and *Cancer productus.* The range of temperature and the salinity of the hydrographic stations which may be correlated with the above dredge stations (as given in appendix III, p. 354) are respectively 11.0° to 13.5° C and 26.6 to 31.6.

Genus **Nectocrangon** Brandt

Rostrum wanting. Eyes nearly concealed or hidden by the carapace. Dactyls of fourth and fifth pairs of legs dilated and more or less adapted for swimming..

Nectocrangon californiensis Rathbun

Nectocrangon californiensis Rathbun, Proc. U. S. Nat. Mus., 24, 892, 1902; H. A. E., 10, 140, figs. 80, 81, 1904.



a *b*

Fig. 71. *Nectocrangon californiensis,* ♂; *a,* lateral view of carapace and anterior portion of abdomen, × 2; *b,* dorsal view of carapace and abdomen, × 2 (from Rathbun, U. S. N. M.).

Characters.—First and second abdominal segments not carinated; third and fourth segments only feebly carinated; each carina of the sixth segment terminating in a small, sharp tooth or spine. Carapace with only two median spines behind spine on anterior margin which, outside of orbital fissure, is furnished with two spines close together instead of one as in the allied species. Antennal scale with spine extending only slightly beyond the blade. Hands from three and a half to four times as long as wide.

Dimensions.—Type, male: length 31 mm., length of carapace 8.6 mm.

Type Locality.—Off Santa Catalina Island, California, 80 fathoms (''Albatross'' station 3664).

Distribution.—Santa Cruz and Santa Catalina Islands, California, 59 to 155 fathoms.

Genus **Paracrangon** Dana

Rostrum elongate, a laterally compressed, suberect spine. Eyes free. Second pair of legs wholly absent.

Paracrangon echinata Dana

Paracrangon echinatus Dana, Proc. Acad. Nat. Sci. Phila., **6**, 20, 1852; Crust. U. S. Expl. Exped., **1**, 538, 1852, pl. 33, fig. 6, 1855; Holmes, Occas. Papers Calif. Acad. Sci., 7, 176, pl. 2, figs. 36, 37, 1900.

Paracrangon echinata Rathbun, H. A. E., **10**, 143, 1904.

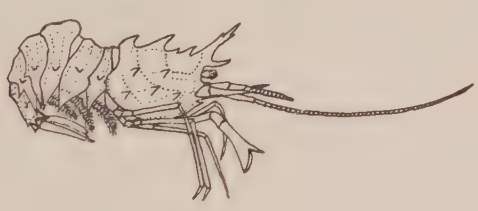


Fig. 72. *Paracrangon echinata;* lateral view, × ¾ (after Dana).

Characters.—Rostrum long, obliquely erect; posterior margin with one tooth near the middle; anterior margin with one tooth near the tip, and at base a long curved spine. Carapace with a median carina unequally four-toothed; sides carinated in such a way as to form irregular quadrangular spaces, with spines at most of the angles; on the anterior margin there is a spine at the outer angle of the orbit and another at the anterolateral angle. First pair of legs about as long as the maxillipeds; upper margin of merus terminates distally in a tooth; hands narrow, elongate, about four times as long as wide; digital spine very long and slender, directed in an obliquely longitudinal direction; anterior margin more longitudinal than transverse. Third pair of legs (the second are lacking) very slender, barely reaching to end of first pair; fourth and fifth pairs of about equal length and slightly exceeding first pair in length. Abdomen carinate behind second segment, carina of third being especially high; on sixth segment and telson it is medially sulcate; abdominal pleura of male much more spiniform than in female.

Dimensions.—Type: length 45 mm.

Type Locality.—Puget Sound.

Distribution.—Port Etches, Alaska, to off La Jolla, California; Japan (Balss).

Remarks.—Heretofore *P. echinata* had not been definitely recorded south of Puget Sound. In the ''Albatross'' collections, however, there are three specimens which had been taken off the Californian coast; two, an ovigerous female and an

immature specimen, from a depth of 38 to 45 fathoms, off Santa Rosa Island ("Albatross" station 4431), and one, a male from 46 to 56 fathoms, in Monterey Bay ("Albatross" station 4551). Still another California specimen is contained in the collection of the Scripps Institution; it was taken July 11, 1905, in 110 fathoms, off La Jolla (haul 998).

Suborder Reptantia

Key to the Tribes of the Reptantia

I. Third pair of legs like the first. Abdomen *macrurous*, straight, symmetrical, well armored, with good pleura and strong tail-fan, lobes of first segment clipping the carapace.

A. Rostrum small or wanting, third pair of legs simple and subcylindrical, carapace fused at sides to the epistome. Exopodites of last pair of abdominal appendages without sharp suture. (Not known north of San Luis Obispo.)

Palinura, p. 105.

B. Rostrum of good size; third legs chelate. Carapace free from the epistome. Exopodites of last pair of abdominal appendages divided by a suture. (Except for the crayfishes, fresh-water forms, not dealt with in this paper, not found in California waters.)

Astacura.

II. Third pair of legs unlike the first, abdomen rarely *macrurous.*

A. Abdomen fairly large, *anomurous;* reduced in some of its features, but showing clear traces of some function other than that of reproduction, and almost always carrying biramous limbs on the sixth segment. Tail-fan usually present, uropods biramous, absent only in the Lithodidae. Carapace not fused with epistome. Antennae situated external to the eye, with long flagellum, often with movable antennal scale. Last thoracic sternum free, its legs always differing clearly from the third pair in size and position and nearly always in size and shape.

Anomura, p. 109.

B. Abdomen comparatively small, *brachyurous;* small, straight, symmetrical, bent under the thorax, showing no traces of other function than reproduction, and without biramous limbs on the sixth segment. Tail-fan not developed, uropods rarely present, never biramous, only in the Dromiidae are they present and then only in a rudimentary condition. Carapace fused with epistome at sides and nearly always in the middle. Antennae situated internal to the eye, seldom with long flagella, and never with a movable scale. Last thoracic sternum fused with the rest, its legs often like the others.

Brachyura, p. 182.

Tribe PALINURA

KEY TO THE SUPERFAMILIES AND FAMILIES OF THE PALINURA

I. All of the legs chelate, except sometimes the last pair; the first larger than the rest. First joint of antennae not fused with the epistome; an antennal scale present. Pleopods present on first abdominal somite; tail-fan not softer behind than before, without sutures; telson pointed (Superfamily *Eryonidea*).

Eryontidae, p. 105.

II. None of the legs chelate, except sometimes the first pair; none much longer than the rest. First joint of antennae fused with the epistome; no antennal scale present. Pleopods absent from first abdominal somite: tail-fan divided by indistinct sutures into a soft hinder part and a harder front half; telson roughly square behind (Superfamily *Scyllaridea*).

A. Carapace subcylindrical. Eyes not enclosed in separate orbits formed by the edge of the carapace. Antennae with flagella.

Palinuridae, p. 107.

B. Carapace depressed. Eyes enclosed in separate orbits formed by the edge of the carapace. Antennae with flat scales in place of flagella. (Not found off California.)

Scyllaridae.

Family ERYONTIDAE

Carapace either depressed with very sharply defined lateral borders or subglobose; rostrum wanting, or represented by a small spine or pair of spines. Eyes rudimentary and eye-stalks immovably fixed in the orbital notches of the anterior margin of the carapace. Antennal peduncle five-jointed, basal joint not fused with the epistome; flagellum lash-like; the renal tubercle of the basal joint of the peduncle is remarkably prominent. Telson pointed.

Genus **Eryonicus** Bate

Carapace subglobose, much inflated, and larger than the abdomen; integument almost membranous. Antennules and antennae shorter than the carapace; renal tubercle on basal segment of antennae nearly equaling the peduncle in length.

Eryonicus agassizi Bouvier

Plate 15, figures 1 and 2

Eryonicus caecus? Faxon, Bull. Mus. Comp. Zool., **24**, 197, 1893; Mem. Mus. Comp. Zool., **18**, 110, pl. B, fig. 2, pl. xxix, figs. 2–2*f*, pl. xxx, 1895 (not *Eryonicus caecus* Bate); Selbie, Sci. Invest. Fisheries Ireland, **1**, 26, 1914; Sund, *Nature*, **95**, 372, 1915.

Eryonicus Agassizi Bouvier, Bull. Inst. Oceanog. Monaco, **309**, 2, 1915.

Characters.—Rostrum represented by a pair of small spinules. Median ridge of carapace armed with small spines, arranged as follows: Rostrum + 1, 2, 1, 1, or

none; cervical groove, 2, 2, 1, 2. Otherwise the principal spines of the carapace are situated as follows: subdorsal or branchial ridge, five; one on branchial area between median and branchial carinae; lateral carina, running from external angle of the orbit to the posterior margin of the carapace, with sixteen spines arranged six-three-seven, of which the last four are the largest; upper of two ridges, below the lateral carina, running from the outer side of the base of the antenna almost to the hinder border of the carapace, spinulose along the anterior third of its course; the lower ridge, beginning on the margin of the pterygostomian region, one-third of the way from the anterior end of the carapace and curving outward and backward to the posterior margin of the carapace, with five spines which decrease in length from the first to the fifth, followed by small denticles; the anterior spines in this last series are the largest on the body.

Eyes rudimentary, without corneae; eyestalks consisting of a large lobe, immovably fixed in a deep sinus in the anterior border of the carapace. This lobe sends forth an elongated, cylindrical process, directed outward and downward below the antero-lateral angle of the carapace; the anterior margin of the lobe bears a prominent papilla, or tubercle.

Abdomen with five longitudinal rows of spines, one median and two pairs of lateral; median row with one spine on the first abdominal somite, one or two on the second, two or one on the third, two or three on the fourth, two on the fifth, one on the sixth, and two on the base of the telson.

Dimensions.—Type, male: length from rostrum to end of telson 62.5 mm., of carapace 34.5 mm., of abdomen 30 mm.; specimen taken off California by the "Albatross": length from rostrum to end of telson 75 mm.

Color.—Of Faxon's specimens in life, "purplish red, the branchial regions livid." California specimen: "extremities shaded with pale rose, body parts flesh color."

Type Locality.—Off Malpelo Island, vicinity Gulf of Panama, 1201 fathoms ("Albatross" station 3375).

Distribution.—Gulf of Panama and vicinity; surface to 1832 fathoms (Faxon). Also taken off San Nicolas Island, California in 654 to 704 fathoms ("Albatross" station 4405).

With respect to the great depth recorded for some of the captures of *Eryonicus* Faxon says (1895, p. 110):

> The huge spherical carapace of *Eryonicus* perhaps serves as a hydrostatic apparatus, by means of which the animal is enabled to lead a free-swimming life at some distance above the ocean bottom. The great depths of the soundings at some of the stations where *Eryonicus* has come up in the trawl may be delusive, as in the case of swimming *Hoplophoridae* and *Sergestidae*, which are often found in the trawl that has been lowered to great depths. At station 3388 ["Albatross," Gulf of Panama], twenty-five miles from the nearest land, where the depth was 1168 fathoms, the Tanner self-closing net [described in Agassiz, 1892, pp. 46–48] was lowered to 400 fathoms and towed for seventeen minutes. The net was hauled up to the surface after the lower part had been securely closed by the messenger at 400 fathoms. The lower part of the net was found to contain absolutely no life, while the upper part, which had remained open all the way from 400 fathoms to the surface, contained four specimens of *Eryonicus*, 19–29 mm. long, together with other swimming forms [Agassiz, 1892, pp. 48, 49]. At stations 3375 and 3383 ["Albatross," Gulf of Panama and vicinity], although captured in the trawl which had been lowered to depths of 1201 and 1832 fathoms, *Eryonicus* was found associated with several swimming forms. At station 3403 ["Albatross"], a specimen of *Eryonicus spinulosus* [Faxon, 1895, p. 116] was brought up in the trawl where the bottom was only 384 fathoms.
>
> From these facts it is possible, if not probable, that *Eryonicus* leads a free-swimming existence at depths moderate compared with those frequented by truly

abyssal species. On the other hand, the structure of its visual organs and its absence from collections made with the surface tow-net preclude the thought of its living at or very near the surface.

Remarks.—There seems to be some variation in the number of spines before the cervical groove. The formula above in the "*Characters*" adapted from Faxon gives one more spine just before the cervical groove than appears in the "Albatross" California specimen, for which the formula reads: Rostrum + 1, 2, 1; cervical groove 2, 2, 1, 2. That this is no more than variation seems borne out by an examination of several of the juvenile specimens identified by Faxon and deposited in the U. S. National Museum. For three of these the formulas are:

1. (Length 37 mm.): Rostrum + 1, 2, 1, 1, denticle; cervical groove, 2, 2, 1, 2.
2. (Length 20 mm.): Rostrum + 1, 2, 1, denticle; cervical groove, 2, 2, 1, 2.
3. (Length 19 mm.): Rostrum + 1, 2, 1, denticle; cervical groove, 2, 2, 1, 2.

There are also some slight variations in the number of median abdominal spines, as well as slight discrepancy between Faxon's colored figure (Faxon, 1895, pl. B) and his published description, as follows:

Abdominal somite	1	2	3	4	5	6	Telson
Faxon's description	1	2	2	2	2	1	2
Faxon's colored figure	1	1	2	2	1	2	3
Faxon's juvenile No. 1	1	1	2	3	2	1	2
Faxon's juvenile No. 2	1	1	2	2	2	1	2
Faxon's juvenile No. 3	1	1	2	2	2	1	2
"Albatross" California specimen	1	1	1	3	2	1	2

In Bouvier's paper cited in synonymy above, the name *agassizi* for Faxon's *caecus* is introduced without comment: " . . . *E. Agassizi* (= *E. cæcus* Faxon) . . ."

Owing to the fact that Bate had only one immature specimen it is not easy to point out a number of valid differences between his species and that described by Faxon; but one which seems to be of prime importance is the presence of only one median spine on the base of the telson in Bate's material whereas all of Faxon's specimens and my own have two, a character which would immediately separate them in the key given by Selbie (1914, p. 28) for the species of *Eryonicus*.

Family Palinuridae

Carapace longitudinally subcylindrical, with rostrum wanting or represented by a tooth. Orbits only partially excavated; the eyes may be protected by a spine above or below, or both, but are never lodged in true orbits. Antennal peduncle four-jointed, the basal joint fused with the epistome; with a long, cylindrical, quite rigid, multiarticulate flagellum. Telson roughly square behind.

Genus **Panulirus** White

No central rostriform tooth. The ocular segment exposed and membranous, ocular peduncles small and free. Flagella of antennules long and slender, their segment produced considerably in advance of the frontal margin, and generally armed with strong teeth.

Panulirus interruptus (Randall)

Palinurus interruptus Randall, Jour. Acad. Nat. Sci. Phila., **8**, 137, 1839.
Panulirus interruptus Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 491, 1854; Rathbun, R., The Fisheries of the U. S., sec. 1, p. 780, pl. 270, 1884; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 168, 1900; Rathbun, H. A. E., **10**, 148, 1904; Allen, Univ. Calif. Publ. Zool., **16**, 139, 1916; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 67, 1916.

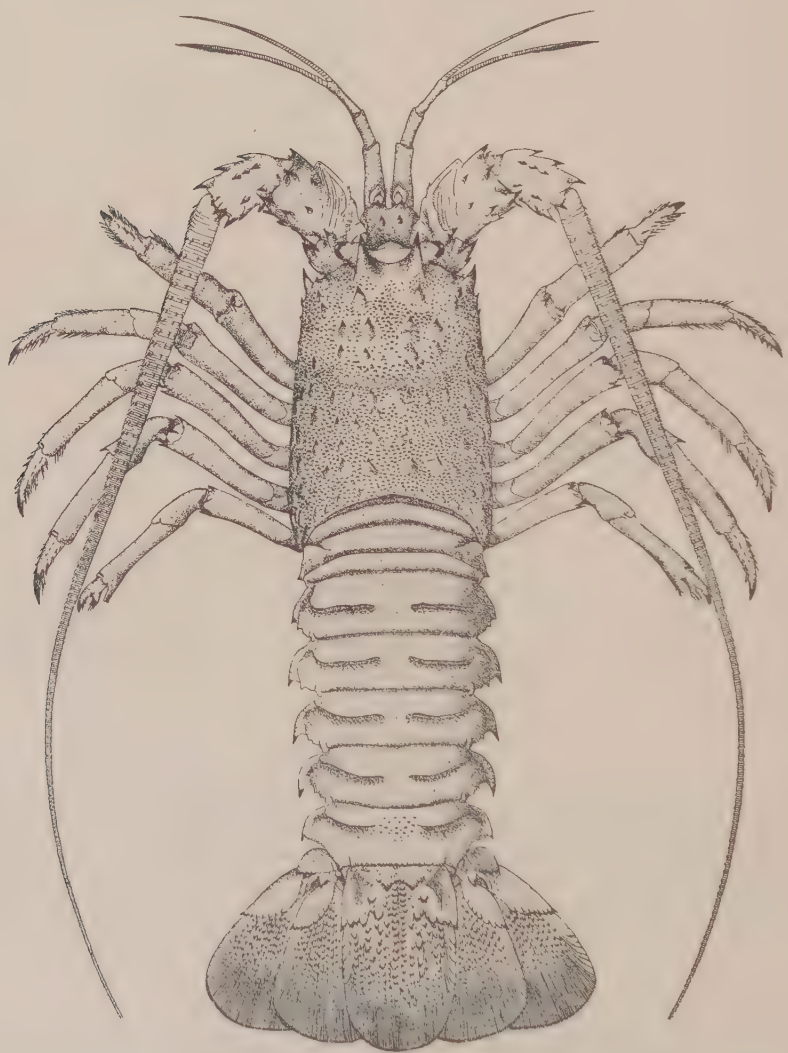


Fig. 73. *Panulirus interruptus* (from Rathbun, U. S. N. M.).

Characters.—Peduncle of the antennules slightly exceeds that of the antennae; first joint about as long as the next two; second joint about three-fourths as long as the third; flagella longer than the peduncle, the outer setose on one side

except near the base. Peduncle of the antennae armed with short, stout spines, flagellum spinulous, compressed at the base, and exceeding the body in length. Abdominal segments furnished with a pair of transverse dorsal setose sulci, which do not meet in the middle line except indistinctly on the sixth segment.

Dimensions.—Types: 127 mm.–228.6 mm., ranges up to 60.9 cm. in length (Randall).

Color.—Feet vittate alternately with red and olivaceous (Randall). There is a large range of color variation, from almost black, through shades of dark mahogany, reddish purple, to a light red color. Fishermen speak of albino specimens.... In examining traps laid among the kelp all shades were found in the same trap (Allen).

Type Locality.—California.

Distribution.—San Luis Obispo, California, to Rosalia Bay, Lower California. To a depth of 35 fathoms (Allen). Mexico (Ortmann, Streets). Except for one immature specimen in the collection of the National Museum, labeled Monterey Bay, this species has never been recorded north of San Luis Obispo, California.

Remarks.—This is the common "lobster" of the Pacific coast. It inhabits rocky ledges in rather deep water, and is taken in considerable numbers by the fishermen at Santa Barbara and other ports on the coast south of San Francisco. North of this point it is never found. The traps, or "pots," used in their capture are similar to those in which lobsters are taken on the New England coast, consisting of a strong wooden basket, with a funnel shaped entrance projecting inward (Stimpson). The young of the lobster are often found in the tide pools at Laguna Beach (Hilton).

Tribe ANOMURA

KEY TO THE SUPERFAMILIES AND THE CALIFORNIA FAMILIES OF THE ANOMURA

I. Second to fourth legs with last joint curved and flattened. First pair styliform or subchelate. Tail-fan not adapted for swimming. Abdomen bent under thorax (Superfamily *Hippidea*).

A. First pair of legs simple; carapace subcylindrical, evenly rounded, with wings which cover legs, anterolateral angles unarmed.

Hippidae, p. 173.

B. First pair of legs subchelate; carapace flattened, with longitudinal median ridge, without wings to cover legs, anterolateral angles spined.

Albuneidae, p. 171.

II. Second to fourth legs with last joint not curved and flattened. First pair of legs chelate.

A. Uropods present, adapted for swimming, tail-fan well developed. Abdomen symmetrical, pleura well developed.

1. Body depressed, abdomen bent under, folded upon itself or against thorax, often with a transverse suture on telson (Superfamily *Galatheidea*).

a. Abdomen bent upon itself, but not folded against thorax; body shrimp-like; first legs greatly elongated, slender.

Galatheidae, p. 162.

b. Abdomen folded against thorax, body crab-like, first legs only moderately elongate, stout.

Porcellanidae, p. 174.

2. Body compressed, abdomen extended, straight, no transverse suture on telson (Superfamily *Thalassinidea*).
   a. Abdominal pleura large.

      Axiidae, p. 110.

   b. Abdominal pleura small or absent.

      Callianassidae, p. 114.

B. Uropods either present or absent; when present not adapted for swimming but for holding the body in hollow objects; abdomen nearly always asymmetrical (Superfamily *Paguridea*).

1. Carapace firm in fore part and soft in hinder part. Rostrum much reduced. Uropoda present, adapted for holding body in hollow objects. Abdomen soft, showing no trace of segmentation, straight or twisted, some of the appendages lost, remaining ones much reduced. Penultimate pair of thoracic legs much shorter than those in front of them (the true hermit crabs).

   Paguridae, p. 121.

2. Carapace firm all over, body crab-like. Rostrum spiniform or tuberculiform. Uropoda wanting. Abdomen more or less firm, sometimes quite soft, often segmented, bent under thorax. Penultimate pair of thoracic legs at least as well developed as those in front.

   Lithodidae, p. 146.

Family Axiidae

Body shrimp-like. Abdomen extended, abdominal pleura large, tail-fan well developed, adapted for swimming. First pair of legs chelate and subequal; second pair small, chelate and equal; last three pairs simple. Antennal peduncle five-jointed; antennal scale present as a movable, at times microscopic, thorn-like structure between the second and third joints of the peduncle; an immovable (antennal) thorn also present outside the scale on the second joint.

Key to the California Genera of the Axiidae

I. Eyes pale, without pigment.

   Calastacus, p. 112.

II. Eyes pigmented.

   Axiopsis, p. 110.

Genus **Axiopsis** Borradaile

Carapace in front of cervical groove laterally compressed, forming dorsally a well marked flat area or platform; without a median dorsal keel behind the cervical groove, except sometimes a mere suggestion just before the posterior border. Eyes well pigmented. Antennal "thorns" long or of middle size. Exopodite of uropods with a suture.

Axiopsis spinulicauda (Rathbun)

Axius spinulicauda Rathbun, Proc. U. S. Nat. Mus., 24, 886, 1902; H. A. E. 10, 149, fig. 90, 1904.

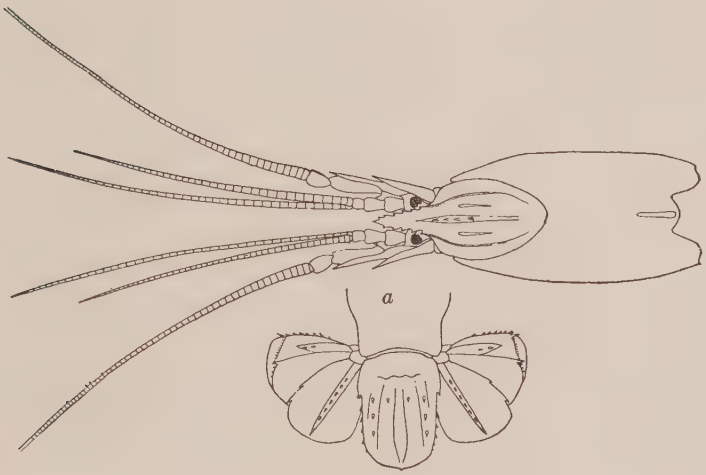


Fig. 74. *Axiopsis spinulicauda*, ♀, × 2; *a*, dorsal view of anterior portion; *b*, tail-fan (from Rathbun, U. S. N. M.).

Characters.—Rostrum reaches the middle of the second joint of antennular peduncle, slightly deflexed, longitudinally channeled; armed on either side with five to six teeth. Gastric region of carapace traversed by five carinae, all of which fade out before reaching the cervical groove; the median one extends along the basal third of the rostrum, and is armed with four spines just behind the line of the orbits; outer carinae are a continuation of the side margins of the rostrum; outer and intermediate carinae unarmed; in front of the narrow median posterior lobe of the carapace, the surface is compressed or pinched to form a short smooth ridge. Eyes black, of same diameter as the stalk, not reaching middle of basal antennular segment. Outer maxillipeds reach the end of the antennal peduncle. Abdomen smooth above; pleura sculptured and pubescent.

Dimensions.—Type, female: length of carapace and rostrum along the median line 19.6 mm., length of rostrum 3.5 mm., of abdomen 31.5 mm.

Type Locality.—Off Bodega Head, California, 62 fathoms ("Albatross" station 3172).

Remarks.—This species apparently belongs to the genus *Axiopsis* Borradaile (1903, p. 538). The exopodite of the uropods shows a suture and the eyes are well pigmented, but as there is a suggestion of a keel at the posterior end of the median line of the carapace that portion of Borradaile's definition regarding "no keel on the carapace behind the cervical groove" must needs be modified to include this species. Except for the well pigmented eyes it fits almost as well under *Calastacus* below, as does *C. quinqueseriatus* Rathbun.

Genus **Calastacus** Faxon

Carapace subcylindrical, back arched, dorsally carinate; cervical groove distinct. Eyes almost or quite without pigment. Antennal "thorns" both of good size. Exopodite of uropods with a suture.

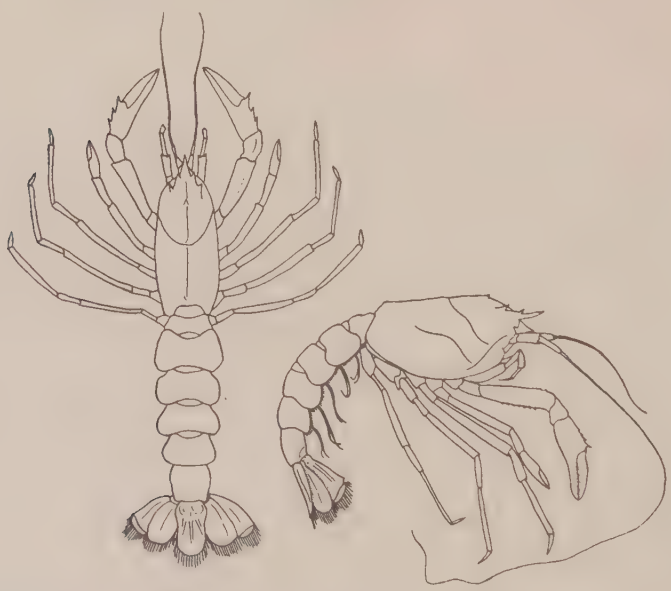
Key to the California Species of Calastacus

I. Carapace granulate; no spines behind those at the base of rostrum. (Known only from 345 + fathoms.)
investigatoris, p. 112.

II. Carapace not granulate; five rows of spines behind the rostrum. (Known only from 200 + fathoms.)
quinqueseriatus, p. 113.

Calastacus investigatoris Anderson

Calastacus investigatoris Anderson, Jour. Asiatic Soc. Bengal, 65, pt. 2, p. 97, 1896; Illus. Zool. "Investigator," Crust., pt. 4, pl. 25, fig. 1, 1896; Alcock, Descr. Cat. Indian Deep Sea Crust. Dec. Macr. Anom. Indian Mus., p. 191, 1901; Rathbun, H. A. E., 10, 151, 1904.



a *b*

Fig. 75. *Calastacus investigatoris; a*, dorsal view; *b*, lateral view (after Alcock).

Characters.—Carapace (rostrum included), measured in the middle line, as long as the first five and a half abdominal somites; surface studded with sharpish, vesiculous granules; finely carinated in the middle line, carina terminating in a vesiculous tubercle and having a similar tubercle in the middle of its gastric course; cervical and branchial grooves very conspicuous. Rostrum not quite reaching end of second joint of antennular peduncle, its sides prolonged onto the gastric region as two sharp ridges, each of which carries two spines. In the

female the chelipeds are just over half the total length of the body, the hand comprising more than two-fifths their total length; the lower border of the ischium and merus, the upper border of the palm, and the distal half of the merus are spinose; a salient serrulate ridge runs along the lower border of the outer surface of palm and fixed finger, and there are some scattered miliary granules on both surfaces of the palm; the palm is a little longer than the carpus and a little shorter than the fingers; the fingers are slender and sharp, and do not meet at base, the cutting edge of the fixed finger is finely serrulate; there are a few setae on the fingers and palm.

Color.—In life: abdomen light brown, carapace very pale pink, fading to slate color on the sides (Alcock).

Dimensions.—Type, female: length of carapace and rostrum 22 mm., of abdomen 32.5 mm.

Type Locality.—Arabian Sea, off the coast of Sind, 947 fathoms.

Distribution.—Also taken by the "Albatross," south of the Sannak Islands, Alaska, 483 fathoms; off Cascade Head, Oregon, 345 fathoms; off San Diego, California, 417 fathoms (Rathbun).

Calastacus quinqueseriatus Rathbun

Calastacus quinqueseriatus Rathbun, Proc. U. S. Nat. Mus., **24**, 887, 1902; H. A. E., **10**, 151, fig. 91, 1904.

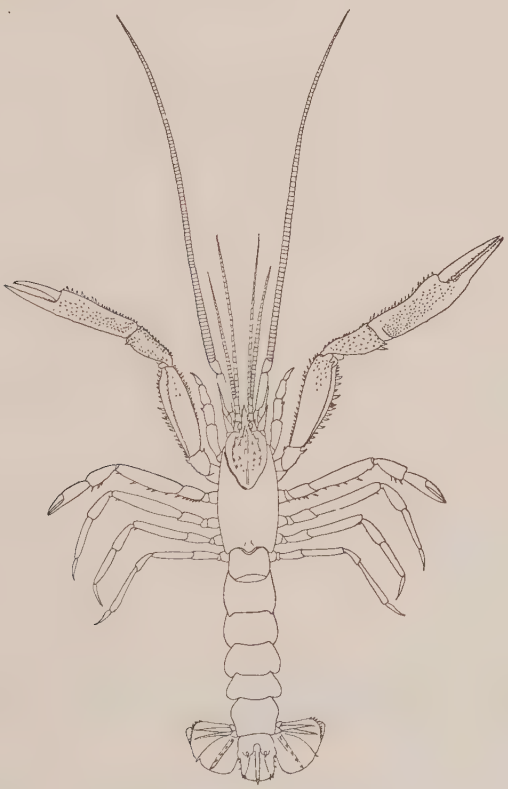


Fig. 76. *Calastacus quinqueseriatus*, ♂, × about ¾ (from Rathbun, U. S. N. M.).

Characters.—Carapace (rostrum included), measured in the middle line, as long as the first five abdominal somites; its surface pitted, especially on the inferolateral portions, a few feeble setae springing from the pits; cervical groove deep, branchial grooves indistinct. The rostrum reaches to the end of the second joint of the antennular peduncle and is tipped with a spine; its lateral margins are armed with three to seven spines; the prolongations of these margins are armed with five to six spines, and form a horseshoe on the carapace which is open behind and outlined in front by a groove a little posterior to the orbit. The median carina extends from the middle of the rostrum to the rear of the horseshoe and is from two- to six-, usually three-spined at its middle. Between the median carina and the sides of the horseshoe is another row of three to five spines. The chelipeds are unequal, the longer one in the male nearly as long as the body; setose; its inner surface and also the outer surface of carpus and hand covered with sharp granules or short spines; upper margin spinose, also lower margin of merus; lower outer margin of merus outlined with very short, blunt spines and a single longer distal spine; lower margins of propodus armed with dentiform granules, margins subparallel. Fingers shorter than palm in adult males, just as long as palm in smaller males and females; usually slightly gaping at base; occludent edges finely and irregularly dentate. The stouter cheliped may be longer or shorter than the slender one. In the female the chelipeds are two-thirds as long as the body.

Dimensions.—Type, male: length of carapace and rostrum 28 mm., of abdomen 41 mm.

Type Locality.—Off San Luis Obispo Bay, 200 fathoms ("Albatross" station 3196).

Distribution.—Also taken by the "Albatross," off Point Sur, 298 fathoms; off San Simeon Bay, 160 fathoms; off San Luis Obispo Bay, 252 fathoms; off Point Conception, 233 to 284 fathoms; Santa Barbara Channel, 205 to 280 fathoms; off Anacapa Island, 388 fathoms, and off San Nicolas Island, California, 1084 to 1100 fathoms.

Family Callianassidae

Body shrimp-like. Abdomen extended; abdominal pleura small or absent; tail-fan well developed and adapted for swimming. First pair of legs unequal or subequal, perfectly or imperfectly chelate; third and fourth pairs simple, others variable. Antennal peduncle five-jointed; antennal scale quite vestigial; no antennal thorn.

Key to the California Genera of the Callianassidae

I. Rostrum of good size, though short, tridentate, rough and hairy. First pair of legs subequal, with very small pollex, tending to become subchelate; none of remaining pairs chelate. Eye peduncles cylindrical. External maxillipeds pediform.

Upogebia, p. 115.

II. Rostrum small, reduced to a small point or absent. First pair of legs very unequal, with well developed chelae; second pair small and chelate; fifth pair subchelate. Eye peduncles flattened. External maxillipeds operculiform.

Callianassa, p. 116.

Genus **Upogebia** Leach

First pair of legs subequal and subchelate; remaining pairs simple. Eye-stalks cylindrical; cornea terminal. Rostrum short, stout, tridentate.

Upogebia pugettensis (Dana)

Gebia pugettensis Dana, Proc. Acad. Nat. Sci. Phila., **6**, 19, 1852; Crust. U. S. Expl. Exped., pt. 1, p. 510, 1852, pl. 32, fig. 1, 1855; Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 488, pl. 21, fig. 2, 1857; Lockington, Ann. Mag. Nat. Hist. (5), **2**, 299, 1878.

Upogebia pugettensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 157, 1900; Rathbun, H. A. E., **10**, 153, 1904.

a *b*

Fig. 77. *Upogebia pugettensis; a*, lateral view of carapace, × 2 (after Dana); *b*, hand with setae removed, × ⅘ (after Stimpson).

Characters.—Upper portion of carapace in front of cervical groove flattened, scabrous, and hairy; marked with three longitudinal grooves, median groove the shortest; front tridentate, with median tooth large, horizontal, and triangular, lateral teeth short. Eye-stalks short, reaching very little farther forward than lateral teeth of front.

Dimensions.—Type: length 50.8 mm. The length of the carapace of the Bay specimens ranges from 11 to 14 mm.

Type Locality.—Puget Sound.

Distribution.—From southeastern Alaska to San Quentin Bay, Lower California (Rathbun).

Remarks.—This species excavates its subterranean burrows in the sand and mud of beaches, near low water marks, preferring that which is more or less indurated (Stimpson).

Biological Survey of San Francisco Bay.—Although only three specimens were taken in the course of the survey, one at Sausalito, February 8, and two at Tiburon, April 29, 1913, Lockington says:

This species is exceedingly abundant in San Francisco and Tomales bays, and frequently attains a length of six inches or even more.

The subterranean passages made by it are usually nearly perpendicular, about an inch across, and very neatly rounded in section, with the walls smooth as if plastered, the smoothness resulting entirely from the pressure of the animal's body as it pushes itself upwards and downwards by the action of its terminal abdominal segments.

The burrows are not confined to strata of sand but are abundant also in mud, in sandy shingle, and even among rocks, ranging upwards almost to high-water

mark, and downwards to at least three or four fathoms, since large specimens were brought up in abundance by the dredging machines in Oakland Harbor.

Almost every specimen collected in Tomales Bay, in the month of May, bore upon its abdominal feet either the curious Isopod *Phyllodurus abdominalis* [see Stimpson, in synonymy above, p. 511] or a small bivalve mollusk, *Pythina rugifera* Carpenter.

While most of the smaller individuals are accompanied by a pair of *P. abdominalis,* the larger specimens were free from this crustacean but in many cases bore the mollusk above mentioned.

In only one case, out of over a hundred specimens dug up in Tomales Bay, were the mollusk and the Isopod found in company upon the same *Gebia;* and in this case the *Gebia* was of middling size and the mollusk very small. On specimens collected July 4, I did not find the bivalve, and the *Phyllodurus* was less common than in May.

In San Francisco Bay I have not as yet detected *Pythina rugifera,* but *Phyllodurus* is sufficiently common.

Genus **Callianassa** Leach

First pair of legs very unequal, with well developed chelae; second pair small and chelate; fifth pair subchelate. Eye-stalks triangular or oblong, flattened; cornea dorsal, median, small or absent. Rostrum short, triangular, rudimentary, or absent.

Key to the California Species of Callianassa

I. Front with median tooth either obscure or not prominent. Eyes pigmented.
  A. Eye-stalks with acute and divergent extremities.
    1. Median prominence of front rounded; cornea at middle of eye-stalk; large cheliped of male very broad, the carpus very little longer than wide, but considerably longer than palm, almost twice as long.

californiensis, p. 117.

    2. Median prominence of front subacute; cornea just behind middle of eye-stalk; large cheliped of male elongate, carpus from one and one-half to twice as long as wide, carpus and palm subequal.

longimana, p. 117.

  B. Eye-stalks oblong, their inner extremities tuberculiform and not diverging; cornea in front of middle of eye-stalk; carpus of large cheliped of male very little longer than wide, and very little longer, sometimes even shorter than palm. (Not known north of Catalina Harbor.)

affinis, p. 119.

II. Front with a sharp and prominent median tooth.
  A. Eyes not pigmented, eye-stalks oblong; large cheliped of male with carpus much shorter than wide. (Known only from 278 + fathoms.)

goniophthalma, p. 122.

  B. Eyes pigmented, eye-stalks with tips acute and divergent; large cheliped of male with carpus a little longer than wide. (Not known south of the Gulf of the Farallones).

gigas, p. 119.

Callianassa californiensis Dana

Callianassa californiensis Dana, Proc. Acad. Nat. Sci. Phila., **7**, 175, 1854; Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 489, pl. 21, fig. 4, 1857; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 159, pl. 2, fig. 27, 1900; Rathbun, H. A. E., **10**, 154, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 63, 1916.

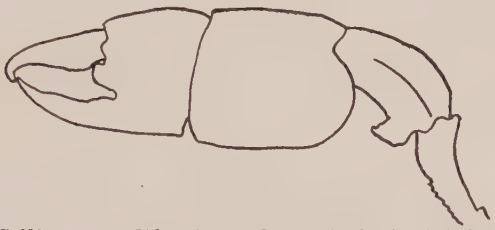


Fig. 78. *Callianassa californiensis,* large cheliped, ♂ (after Holmes).

Characters.—Median tooth of front very short and rounded. Eye-stalks with acute and divergent extremities; pigmented cornea at middle of eye-stalk. Large cheliped of male very broad, the carpus very little longer than broad, but considerably longer than palm.

Dimensions.—Length of male specimen 61 mm., length of larger cheliped 50 mm., of smaller cheliped 32 mm.; length of larger cheliped of female 31 mm., of smaller cheliped 28 mm. (Holmes).

Color.—Of body a delicate orange; anterior feet rose-colored (Stimpson).

Type Locality.—"California."

Distribution.—From Mutiny Bay, Alaska (Lockington), to mouth of Tia Juana River, San Diego County, California (Rathbun).

Callianassa longimana Stimpson

Callianassa longimana Stimpson, Proc. Boston Soc. Nat. Hist., **6**, 86, 1857; Jour. Boston Soc. Nat. Hist., **6**, 490, pl. 21, fig. 5, 1857; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 161, pl. 2, fig. 28, 1900; Rathbun, H. A. E., **10**, 154, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 63, fig. 14, 1916.

Fig. 79. *Callianassa longimana,* large cheliped, ♂ (after Holmes).

Characters.—Median tooth of front small and subacute. Eye-stalks with acute and divergent extremities; pigmented cornea just behind middle of eye-stalk. Large cheliped of male elongate, the carpus twice, or nearly twice as long as broad.

Dimensions.—Length of a male specimen 39 mm., length of large cheliped 39 mm., of small cheliped 22.5 mm. (Holmes). Often grows to be 101.6 mm. in length (Stimpson). The specimens taken in the course of the Bay Survey ranged from 15 to 97 mm. in length, mostly 48 mm. and over.

Type Locality.—Puget Sound.

Distribution.—From Vancouver Island, British Columbia to San Quentin Bay, Lower California.

Remarks.—This species and *C. californiensis* are very similar in practically all other characters except the large chelipeds of the adult males. The females apparently can only be distinguished by the differences in the rostrum and the relative stoutness of the smaller chelipeds, which though very similar also seem to have proportionately a somewhat narrower hand and carpus in *longimana* than in *californiensis.*

Biological Survey of San Francisco Bay.—The Callianassas are soft bodied crustaceans which "generally burrow in sand or mud either in the littoral zone or in deeper waters; at the same time they can swim with considerable activity by means of the pleopods" (Smith, 1909, p. 167).

Within the bay *Callianassa longimana* runs very true to type, having been dredged only at stations having a sandy or a purely mud bottom; two specimens were captured by means of the tow-net (H 4996, 5124). The dredging stations ranged from Pinole Point in the upper bay down through the eastern or muddy portion of the middle bay, to Point San Bruno in the lower bay. All told, this species was taken at seventeen dredging stations, distributed as follows: upper bay three, D 5716, 5717, 5820; middle bay nine, D 5708, 5709, 5714, 5740, 5756, 5822–5825; lower bay five, D 5724, 5727, 5730, 5766, 5835. The two hydrographic stations were made at approximately the same position (Primary hydrographic station 4971, just north of the head of Raccoon Strait (see plate 8).

In view of the great extent of the mud and sandy mud area in the bay (see Sumner, 1914, pls. 5, 6) our limited number of records, which represent only 11% of the total number of dredging stations, must be explained on the ground of the burrowing habits of this crustacean rather than the scarcity of specimens. It is interesting to note, in this connection, that the greater number of specimens per haul were obtained with the "orange-peel bucket" dredge (Sumner, 1914, p. 7, pl. 10). From the six stations at which it was employed an average of eight specimens per haul was returned as compared with one and six-tenths specimens per haul at the eleven at which the ordinary types of dredge or trawl were used. The relative efficiency of the two kinds of apparatus probably accounts for the absence of material from localities in the bay where it can reasonably be expected and

where only the latter types of gear were used. The ranges of temperature and salinity based on the survey observations which we are able to record for *Callianassa longimana* are, respectively, 8.2° to 13.9° C. and 18.3 to 31.7.

Callianassa gigas Dana

Callianassa gigas Dana, Proc. Acad. Nat. Sci. Phila., **6**, 19, 1852; Crust. U. S. Expl. Exped., pt. 1, p. 512, 1852, pl. 32, fig. 3, 1855; Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 489, pl. 21, fig. 3, 1857; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 162, 1900; Rathbun, H. A. E., **10**, 154, 1904.

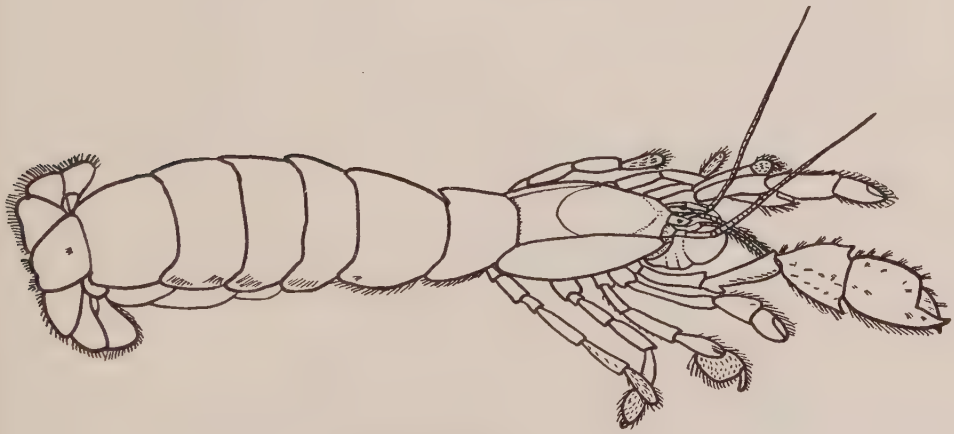


Fig. 80. *Callianassa gigas,* × 4/5 (after Dana).

Characters.—Front with a sharp and prominent median tooth. Eye-stalks with acute and divergent extremities; pigmented cornea behind the middle of the stalk. Large cheliped of male with carpus a little longer than wide.

Dimensions.—Of type: length 114 mm.

Type Locality.—Puget Sound.

Distribution.—Puget Sound (Dana, Calman), Gulf of the Farallones, California, 21 fathoms ("Albatross" station 3150) (Rathbun).

Remarks.—The larger hand of this species is remarkably short and stout (Stimpson).

Callianassa affinis Holmes

Callianassa affinis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 162, pl. 2, figs. 29–30, 1900; Rathbun, H. A. E., **10**, 154, 1904.

Fig. 81. *Callianassa affinis,* ♂; *a,* small cheliped; *b,* large cheliped (after Holmes).

Characters.—Median tooth of front obscure, not prominent. Eye-stalks oblong, with inner extremities tuberculiform, and not diverging; pigmented cornea in front of middle of eye-stalk. Carpus of large cheliped of male very little longer than broad, and very little longer, sometimes even shorter than the palm.

Dimensions.—Of a male specimen from Point Loma, in the collection of the National Museum: length from tip of rostrum to end of telson 61 mm., of cara-

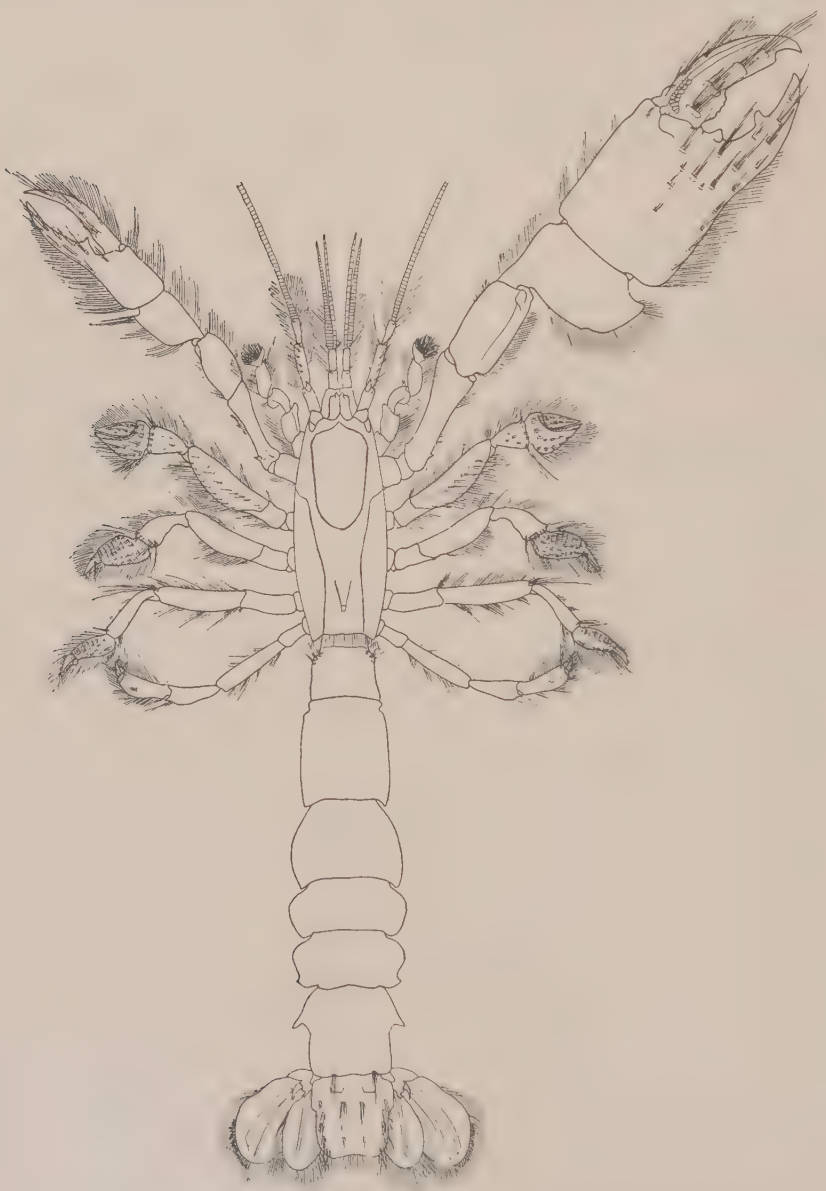


Fig. 82. *Callianassa goniophthalma*, ♂, about natural size (from Rathbun, U. S. N. M.).

pace 17 mm., of large cheliped 50 mm., of hand and fingers 16 mm., of carpus 8.5 mm., greatest width of hand 8 mm., and of carpus 9.5 mm.

Type Locality.—Point Loma, California.

Distribution.—From Santa Monica Bay to San Diego, California (Rathbun).

Callianassa goniophthalma Rathbun

Callianassa goniophthalma Rathbun, Proc. U. S. Nat. Mus., 24, 886, 1902; H. A. E., 10, 154, pl. 8, 1904.

Characters.—Front with a sharp and prominent median tooth which reaches barely one-third the length of the eye-stalks. Eye-stalks reaching nearly to end of first antennular segment, oblong, more than twice as long as wide; sides subparallel; antero-internal angle produced in a tuberculiform tooth, these teeth being slightly divergent from each other; eyes without pigment. Large cheliped of male with carpus much shorter than wide, nearly twice as deep as long, and one-half as long as palm.

Dimensions.—Type, male: length of carapace 30.5 mm., of abdomen 67.5 mm.; of female: length of carapace 22.2 mm., of abdomen 52 mm.

Type Locality.—Off Point Conception, California, 278 fathoms ("Albatross" Station 3198).

Distribution.—Also taken by the "Albatross" in Clarence Strait, Alaska, 322 fathoms, and off Harris Point, San Miguel Island, California, 264 to 271 fathoms.

Family Paguridae

The "hermit crabs." Abdomen soft, showing no trace of segmentation, straight, twisted, or spirally coiled; some of the appendages lost, the remainder much reduced; tail-fan not adapted for swimming, adapted for holding body into hollow objects. Carapace firm in fore part and soft in hinder part. First pair of legs chelate; fourth pair unlike the third.

The Paguridae fall naturally into two groups (Bouvier, 1896*b*, p. 126; Alcock, 1905, p. 21) and for convenience are here so arranged.

I. External maxillipeds approximated at the base. Chelipeds equal or subequal, or left larger than right, p. 122.

II. External maxillipeds widely separated at the base. Right cheliped larger than the left, p. 128.

In the keys and diagnoses below reference is made to abdominal segments; although the abdomen is typically soft and unsegmented the somites can, as a rule, be approximately determined by the number and arrangement of the abdominal appendages when these are present. The abdomen is spirally coiled in all the representatives of the genera here listed except *Pylopagurus minimus* and *P. holmesi*, in which it is quite straight.

Key to the California Genera of the Paguridae

I. External maxillipeds approximated at base. Chelipeds equal or subequal, or left larger than the right.

A. Paired appendages present on the first two abdominal segments of male and first abdominal segment of female. Chelipeds equal or subequal. Fourth pair of legs not chelate.

Paguristes, p. 122.

B. No paired appendages on anterior abdominal segments of either sex. Fourth pair of legs subchelate.

1. Left cheliped much larger than the right; fingers somewhat spooned. *Dardanus*, p. 126.

2. Left cheliped only slightly larger than the right; fingers acuminate. *Holopagurus*, p. 127.

II. External maxillipeds widely separated at base. Right cheliped larger than the left. (As the characters of the following genera are not equally applicable to both sexes, a key including the species of all three is given on page 128.)

A. A pair of appendages on the first abdominal segment either of male only or of female only. Fingers of chelipeds opening and closing obliquely.

1. A pair of appendages on the first and second abdominal segments of the male only. *Parapagurus*, p. 144.

2. A pair of appendages on the first abdominal segment of the female only. *Pylopagurus*, p. 142.

B. No paired appendages on first or second abdominal segment of either sex. Fingers of chelipeds opening and closing horizontally. *Pagurus*, p. 130.

I. External maxillipeds approximated at the base. Chelipeds equal or subequal, or left larger than the right.

Genus **Paguristes** Dana

Chelipeds similar, equal, subequal or one (usually the left) may be larger than the other. Fourth pair of legs simple. External maxillipeds approximated at base. Abdomen with paired appendages other than the uropods on the first two segments in the male, and the first segment of the female.

Key to the California Species of Paguristes

I. Eye-stalks moderately stout, two-thirds to three-quarters as long as width of anterior portion of carapace.

A. Upper surface of hands strongly spined with numerous dark-tipped spines. Eye-stalks of more or less uniform width throughout their entire length. Teeth of front subequal; rostriform tooth reaching about to bases of eye scales.

1. Hands very broad, only about one-fifth longer than wide, outer margin strongly convex; immovable finger at base about twice as wide as movable one. (Not known north of San Francisco.) *bakeri*, p. 124.

2. Hands much narrower, about one-third or more than one-third, longer than wide, outer margin but slightly bowed out; immovable finger at base subequal or but slightly wider than movable one. *turgidus*, p. 123.

B. Upper surface of hands coarsely granulate, armed only with three short stout spines on inner margin behind the dactyl. Distal half of eye-stalks about same width as cornea, proximal half abruptly enlarged, about half again as wide. Rostriform tooth of front reaching to tips of eye scales or slightly beyond, much more prominent, larger and more acute than lateral teeth. (Known only from San Pedro.)

parvus, p. 124.

II. Eye-stalks long and slender, about as long as or slightly longer than greatest width of anterior portion of carapace. Rostriform tooth of front longer, more prominent, and more acute than lateral teeth, reaching to or beyond bases of eye scales. Hands much as in *P. turgidus*. (Not known north of Monterey.)

ulreyi, p. 125.

Paguristes turgidus (Stimpson)

Plate 18, figures 1 and 8

Eupagurus turgidus Stimpson, Proc. Boston Soc. Nat. Hist., **6**, 484, pl. 21, fig. 1, 1857.

Paguristes turgidus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 151, 1900.

Characters.—Hands only moderately broad, about one-third or more than one-third longer than wide, outer margin but slightly bowed out; immovable finger at base subequal with or but slightly wider than movable finger, upper surface of hands strongly spined with numerous dark-tipped spines. Eye-stalks about three-fourths as long as width of anterior portion of carapace. Antennal flagella sparsely haired. Teeth of front subequal, rostriform tooth reaching about to bases of eye scales.

Dimensions.—Type: length 76.2 mm. Length of carapace in the Biological Survey specimens ranged between 10 and 20 mm.

Color.—Yellowish, obscured by the hirsute covering; eye peduncles and internal antennae with a longitudinal streak of crimson (Stimpson).

Type Locality.—Puget Sound.

Distribution.—From British Columbia to San Diego, California, to a depth of 254 fathoms.

Biological Survey of San Francisco Bay.—Paguristes turgidus was dredged at three outside stations, D 5788, 5789, 5806, ranging in depth from 13 to 68 fathoms, with an accompanying temperature range of 9.3° to 11.1° C and a salinity range of 34.0 to 34.3.

Paguristes parvus Holmes

Plate 17, figure 1

Paguristes parvus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 151, pl. 2, fig. 26, 1900.

Fig. 83. *Paguristes parvus,* dorsal view of anterior portion (from Holmes).

Characters.—Rostriform tooth of front long and prominent, reaching to tips of eye scales or beyond, very much larger and more acute than lateral teeth. Upper surface of hands coarsely granulate, armed only with three short, stout spines on inner margin behind the dactyl. Length of eye-stalks measured from orbital margin about two-thirds the width of the anterior portion of the carapace; distal half of eye-stalks about same width as cornea, proximal half abruptly enlarged, about half again as wide.

Dimensions.—Type: length 12.7 mm.

Type Locality.—White's Point, near San Pedro, California.

Remarks.—In the collection of the U. S. National Museum there is a *Paguristes* which is undoubtedly a cotype of Holmes's *parvus.* The label reads, "San Pedro, California; littoral among rocks; July 23, 1895; S. J. Holmes." Except that the eye scales are cut into two instead of three points it fits the description given by Holmes very closely. The specimen is a female about 12.7 mm. in length, the length given by Holmes for the type.

Paguristes bakeri Holmes

Plate 18, figures 2 and 6

Paguristes bakeri Holmes, Occas. Papers Calif. Acad. Sci., **7**, 152, 1900; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 63, figs. 11, 12, 1916.

Characters.—Hands very broad, only about one-fifth longer than wide, outer margin strongly convex; immovable finger about twice as wide at base as movable finger; upper surface of hands strongly spined with numerous dark tipped spines. Eye-stalks about three-fourths, more rarely seven-eighths, as long as width of anterior portion of carapace. Antennal flagella sparsely haired. Teeth of front subequal, rostriform tooth reaching about to bases of eye scales.

Dimensions.—Types, female: length 63.5 mm.; males: length 114.3 and 127 mm. In the Biological Survey material the length of carapace ranged between 9 and 35 mm., mostly about 25 mm. long.

Color.—General color dark reddish, legs more or less colored with blue (Holmes).

Type Locality.—San Diego, California.

Distribution.—From San Francisco to San Diego, California, and the Gulf of California, to a depth of 116 fathoms.

Remarks.—Occasional specimens have the eye-stalks almost as long as the greatest width of the anterior portion of the carapace, but the characteristic broad hands will always serve to distinguish *P. bakeri* from the other species here listed.

Biological Survey of San Francisco Bay.—Paguristes bakeri was only taken at three of the seventeen outside dredging stations, D 5787, 5789, 5790, all between 33 and 46 fathoms. One specimen was taken at the first, and the third station, on a "very fine, green sand" bottom, while two specimens were obtained at the second, on "very coarse variegated sand with a small proportion of fine sand." At each of these stations this species was associated with *Pagurus ochotensis,* in addition at the second with *Paguristes turgidus,* and at the last with *Pylopagurus minimus.* Seven other specimens, also in company with *Pagurus ochotensis,* were obtained on the fishing grounds by the commercial trawlers, July, 1912. The bottom temperature range as observed for this species was 9.4° to 11.0° C; salinity 33 to 34.3.

Paguristes ulreyi sp. nov.

Plate 18, figures 3, 4, 5, and 7

Description.—Anterior portion of carapace longer than wide; front tridentate, rostriform tooth triangular, acute, extending forward at least to base of the eye scales, exceeding lateral teeth by one-half their length; lateral teeth blunt and somewhat tuberculiform. Eye-stalks comparatively very long and slender, length measured from orbital margin about as long as greatest width of anterior portion of carapace, or slightly longer; eye scales each with four to five spiniform teeth at tip; third segment of antennular peduncle exceeds cornea by one-fourth its length. Antennae thickly long-haired beneath, few short hairs above.

Chelipeds equal, hairy; merus spined on upper or anterior edge and on inner border of lower face, outer border of lower face of merus in occasional specimens slightly rugose, and in one specimen from Monterey somewhat spinulose; carpus with five stout spines on upper inner edge; upper surface of hand well spined with dark tipped spines, which are larger on the outer anterior edge of the immovable finger; inner edge of palm behind the dactyl armed with three prominent spines, with two much smaller ones below on inner face, and intermediate between them. Hands somewhat like those of *P. turgidus,* one-third to sometimes nearly one-half longer than wide, but with fingers less acuminate.

Ambulatory legs very hairy on inner or anterior face of dactylus and propodus, anterior pair more so than in any of the species listed in this paper, armature of anterior pair much as in *P. bakeri.*

Dimensions.—Holotype, male (Cat. No. 50427, U. S. N. M.): length 59 mm., length of carapace 22 mm., of anterior portion 12 mm., greatest width of anterior portion of carapace 10 mm., length of right cheliped 33 mm., of hand 13 mm., width of hand 7 mm., length of eye-stalk measured from orbital margin 10 mm. Of paratype, female: length 51 mm., length of anterior portion of carapace 9 mm., width 8 mm., length of eye-stalk measured from orbital margin 8 mm.

Type Locality.—Off Point Loma, San Diego, California ("Albatross" station 4304), 25 fathoms.

Distribution.—Monterey to off San Diego, California, and San Geronimo Island, Lower California, to a depth of 32 fathoms.

Remarks.—Differs from *P. perrieri* Bouvier (Bull. Mus. d'Hist. Nat., p. 7, 1895) in having the eye scales toothed or incised and not entire, longer antennular peduncles, which exceed the eye-stalks instead of falling considerably short of them, and in having the antennal flagella well haired beneath instead of sparsely so. This species is named after Dr. Albert B. Ulrey, Director of the Venice Marine Biological Station, Venice, California.

Genus **Dardanus** Paulson

Chelipeds with few exceptions dissimilar and unequal, the left being much the larger; the finger tips are corneous and blackened and somewhat spooned, especially those of the smaller hand. The fourth pair of legs subchelate. External maxillipeds approximated at the base. No paired appendages on the anterior abdominal segments of either sex.

Dardanus jordani sp. nov.

Plate 17, figures 3 and 4

Description.—Carapace depressed, greatest width across branchial regions about five-sixths the length measured on the median line, sparsely setose, tufts of hairs occurring principally on the antero-lateral margins; median sinuosity of front exceeded by the acutely tipped lateral projections, and itself medially very slightly concave.

The eye-stalks, which slightly exceed the antennular peduncle, are dorsally somewhat flattened and are slightly shorter than the frontal border of the carapace; measured from the anterior margin of the carapace, their length is slightly greater than the width and about as long as the anterior portion of the carapace; the corneae occupy a little more than one-fourth the length of the stalk; the inner anterior margin of the eye scale is incised, forming four or five small teeth, the outermost of which are but mere granulations of the margin.

Chelipeds and legs rather setose toward distal extremities, sparsely so proximally, and well provided with spines on upper and outer faces of dactylar and propodal joints, carpal joints with but comparatively few spines; spines of inner margin of hands and carpal joints of chelipeds stronger than the rest. Hand of large cheliped about twice as long as greatest width, outer margin somewhat concave just below level of bases of fingers (more so than shown in plate 17, fig. 4, owing to slightly oblique presentation of the hand in photographing); fingers about one-fifth shorter than rest of hand; carpus except for the distal third (distal half, measured on outer margin) of its length but little more than two-thirds the width of the hand, but in that portion widening abruptly to form a shelf-like offset toward its antero-external angle to accommodate the width of the proximal margin of the hand. This feature is not well shown in the plate cited, for the reason given above; the offset actually occupies nearly a third of the distal margin of the carpus. Small hand, about two and one-sixth times as long as wide, similar to but narrower than the large hand, outer margin of hand also concave but more evenly so from base to tip; fingers one-sixth longer than the palm, and gaping slightly throughout their entire length except for the black corneous tips.

Dimensions.—Type, male: (Cat. No. 3093, U. S. N. M.) length of carapace 21 mm., of anterior portion 10.5 mm., of large hand 17 mm., width 9 mm., length of large cheliped measured in a straight line (chord) 34 mm.

Type Locality.—San Francisco Bay, collected in 1880 by Dr. D. S. Jordan.

Remarks.—Similar to *D. wood-masoni* Alcock (1905, p. 85, pl. ix, fig. 3), from the Maldive and Andaman Islands, but the large cheliped is relatively not so long. As described, the length of the large cheliped of *D. wood-masoni,* measured in a straight line (chord), is twice that of the sagittal line of the carapace, while that of our species measured in the same manner is but one and a-half as long as such a line. Moreover, as figured by Alcock the anterior portion of the carapace is wider than long and a little shorter than the rest (soft posterior portion) of the carapace measured on the median line. In our species the anterior portion of the carapace is a little longer than wide and equal to the posterior portion in length. *D. wood-masoni* does not show the sudden reduction in width of the carpus of the larger cheliped from the wide distal margin to the narrower proximal portion.

This specimen is a rather remarkable find in that it represents a great northward extension of the range of the genus on the Pacific coast of America. Strange to say it has not been taken since or elsewhere on the coast. Dr. Jordan, to whom I have submitted the tin tag (no. 627) found in the bottle with the specimen says, "Undoubtedly the locality is correct because I took a good deal of pains to pick up such things around San Francisco, . . ., but I fear that I cannot add anything. We used to follow the Chinese shrimp-fishermen with their fine nets about the Bay, and a good many crabs came in in that way." It was entered in the museum catalogues in 1881.

Genus **Holopagurus** Holmes

Left cheliped slightly larger than the right. Fourth pair of legs subchelate. External maxillipeds approximated at base. No paired appendages on the anterior abdominal segments of either sex.

Holopagurus pilosus Holmes

Plate 17, figure 2

Holopagurus pilosus Holmes, Occas. Papers Calif. Acad. Sci., 7, 154, 1900; Alcock, Indian Decapod Crust., pt. II, fasc. 1, pp. 25, 162, 1905.

Characters.—Median projection of front small, blunt, and rounded, reaching about as far forward as, but not exceeding lateral ones. Carapace from corneae of eye-stalks to posterior margin characteristically and strikingly triangular in general appearance. Eye-stalks set very close together, about two-thirds the length of the anterior portion of the carapace, corneae not dilated. Anterior portion of carapace, taken alone, is quite square in form. Chelipeds of similar form, furnished with long hairs and short spines; hands horizontally flattened and covered with scattered spines, which are larger and more thickly set near the rounded margins; palms gently convex, but with a transverse depression just anterior to the base of the fingers, which makes them appear pronouncedly bent upward, larger hand widest across base of the fingers, beyond which it is abruptly contracted, fixed finger rather narrow a short distance beyond the base; smaller hand relatively narrower than the larger, inner and outer faces parallel, fixed finger not so much contracted beyond the base as in the larger hand, its outer margin evenly convex near the base and not slightly concave like its fellow. Dactyls of ambulatory legs long, gently curved, flattened toward the tip, subcylindrical at the

base, about twice the length of the upper side of the propodi, strongly twisted, and armed only with very short, corneous spinules.

Dimensions.—Type: length 114.3 mm., large cheliped 11 mm. longer than smaller one. Length of carapace of the single Bay specimen 28 mm.

Color.—General color yellowish white, the antennae are blue and the anterior portions of the carapace have more or less the same coloration; a peculiar reddish coloration occurs in different parts of the body, notably on either side of the cardiac area of the carapace (Holmes).

Type Locality.—Off San Diego, California, dredged in 25 fathoms.

Distribution.—San Francisco to San Diego, California, to a depth of about 30 fathoms.

Biological Survey of San Francisco Bay.—In the collection there is a single specimen, without a label, undoubtedly taken outside the bay.

II. External maxillipeds widely separated at the base. Right cheliped larger than the left.

Key to the California Species of Pagurus, Pylopagurus, and Parapagurus

I. Dactyls of second and third pairs of legs more or less strongly twisted, longer than anterior portion of carapace, often nearly as long as entire carapace.

A. Large hand with a prominent longitudinal ridge, forming one side of a median subtriangular area, each side of which the palm is deeply excavate; large surface of small hand oblique, triangular and also deeply excavate. (Off California, known only from 211 + fathoms.)
Pagurus tanneri, p. 133.

B. Large hand not ridged or excavated, upper surface spiny, flat or convex; inconspicuously or long haired.

1. Large surface of small hand horizontal; hair on hands short, not reaching to end of spines.
Pagurus ochotensis, p. 130.

2. Large surface of small hand triangular, oblique; hair on hands much longer than, and practically obscuring, spines. (Off California, known only from 240 + fathoms.)
Pagurus capillatus, p. 132.

II. Dactyls not twisted. Small hand more or less swollen; large surface more or less triangular, oblique or vertical; hand in some cases subcylindrical.

A. Upper surface of large hand strongly spined; spines in seven longitudinal rows; both hands thickly set with stiff bristles. (Off California, known only from 266 + fathoms.)
Pagurus setosus, p. 136.

B. Upper surface of large hand granulate or smooth, rarely sharply (spiniform) granulate; sparsely if at all hairy.

1. Dactyls at most but little if any longer than anterior (firm or hard) portion of carapace; never more than one-third again as long.

a. Large hand with upper surface convex, more or less evenly rounded.

i. Small hand not very feeble, at least one-half as wide as greatest width of large hand.

a. Median projection of front triangular and acute.

i. Carpus of large cheliped deeper than wide; inner face flat and perpendicular, forming a sharply distinct angle with the inferior or lower face. Small hand very much compressed laterally, deeper than wide, sides (inner and outer faces) subparallel. Anterior portion of carapace very long, about one-third longer than wide; not hairy, smooth and shining. (Not known south of Monterey Bay.)

Pagurus hemphillii, p. 142.

ii. Carpus of large cheliped not deeper than wide; inner face rounded off below and passing more or less evenly into the inferior or lower surface. Small hand wider than deep, more flattened than compressed; sides laterally swollen rather than parallel. Carapace more or less hairy.

* Anterior portion of carapace wider than long, more or less squarish or squat looking. Eye-stalks short and stout. Acicle typically exceeding eye-stalks, often, however, not so long. Dactyls of ambulatory legs about as long as propodi.

Pagurus hirsutiusculus, p. 137.

** Anterior portion of carapace longer than wide. Eye-stalks moderately stout. Acicle never exceeding eye-stalks. Dactyls quite short and stout, appearing shorter than propodi, sensibly stouter than in preceding species. (Not known north of Humboldt County.)

Pagurus samuelis, p. 139.

b. Median projection of front rounded, short, and low, very blunt or broadly rounded.

i. Small hand with outer face flat-triangular, forming a distinct angle with inferior or lower face; lower face smooth though hairy. Large hand more or less coarsely and irregularly granulate. Ambulatory legs moderately or extremely hairy. (Not known south of Monterey Bay.)

Pagurus beringanus, p. 135.

ii. Small hand with outer face more or less swollen-triangular, not forming a distinct angle with under side; edge evenly rounded; lower face granulated like the outer, scarcely if at all hairy. Large hand more or less evenly and finely granulated. Ambulatory legs sparsely if at all hairy.

Pagurus granosimanus, p. 141.

ii. Small hand comparatively very feeble, less than one-third greatest width of palm of larger hand. Large hand more or less suborbicular, feebly granulated on palm. Median projection of front sharply triangular, acute. (Not known north of Santa Catalina Island.)

Pagurus californiensis, p. 143.

b. Large hand transversely concave at base of fingers, trough-shaped, or more or less discoidal, with raised margins; bent at an angle with the wrist.

i. Greater part of upper surface of large hand markedly discoidal, flat, with raised margins which posteriorly separate it from a narrow convex basal (proximal) portion filling in the angle which the upper surface makes with the wrist, or carpus. (Not known north of Santa Monica Bay.)

Pylopagurus holmesi, p. 144.

ii. Transversely concave, trough-shaped portion of large hand not marked off from and passing over rather evenly into convex basal (proximal) portion.

Pylopagurus minimus, p. 144.

2. Dactyls of ambulatory legs exceedingly long and slender, almost as long as entire carapace, more than one and a half times as long as anterior portion of carapace. Median projection of front prominent, somewhat elongate, tip rounded, sides subparallel.

Parapagurus mertensii, p. 146.

Genus **Pagurus** Fabricius

No paired appendages, except the uropods on the abdomen of either sex. External maxillipeds widely separated at base; exopodites of all three pairs of maxillipeds flagellate. Chelipeds usually dissimilar and unequal, the right being much the larger; very rarely (not in the California species) are they subequal. Fourth pair of legs subchelate.

Pagurus ochotensis Brandt

Pagurus (*Eupagurus*) *bernhardus* var. C, *spinimana;* or sp. *ochotensis* Brandt *in* Middendorff, Reise in den äussersten Norden und Osten Sibiriens, Bd. II, Zool., Th. I, p. 108, 1851.

Pagurus ochotensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 137, 1900; Benedict, Proc. U. S. Nat. Mus., **23**, 463, text fig., 1901; Rathbun, H. A. E., **10**, 157, 1904.

Characters.—Large surface of small hand horizontal, thickly set with slender spines; large hand likewise spiny; both hands hairy, hairs not reaching to the ends of the spines. Anterior portion of carapace wider than long; front tridentate, median and lateral teeth triangular, acute, of about equal prominence. Eye-stalks short and stout, about one-half the length of the anterior portion of the carapace. Acicle much longer than eye-stalks. Dactyls of ambulatory legs spinous, twisted, nearly as long as entire carapace.

Dimensions.—Type: length of carapace 31.8 mm., width 27.5 mm. Length of carapace of Bay specimens generally between 6 and 12 mm.

Color.—Color of dried specimen, yellowish, spotted and banded with red (Brandt). Of alcoholic specimens is straw yellow. Slender streaks of red run longitudinally on the carpal, propodal, and dactyl joints of the ambulatory legs. The merus joints have two transverse streaks of the same color (Benedict).

Type Locality.—Okhotsk Sea.

Distribution.—From Unalaska to San Diego, California, 6 to 80 fathoms (Rathbun). Okhotsk Sea (Brandt). Japan (Stimpson) (Balss).

Biological Survey of San Francisco Bay.—Pagurus ochotensis is the most abundant and widely distributed of the hermit crabs occurring outside of the bay. It was taken at eight (D 5785–5787, 5789–5792, 5806) of the seventeen outside stations. These represent eight of the nine outside stations which were made seaward of the San Francisco bar, that is to say, all stations outside the bar at which the depth did not exceed 46 fathoms. At the station of least depth, D 5806, 13

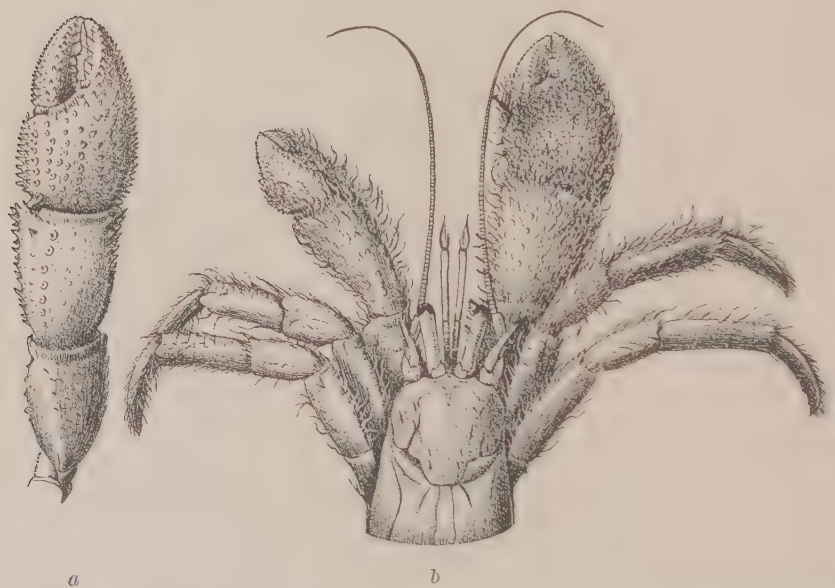
Fig. 84. *Pagurus ochotensis,* natural size (after Benedict, U. S. N. M.).

to 14 fathoms, only two specimens were obtained; at the other stations, which were made in 19 or more fathoms, from eight to forty specimens were taken. The bottom, except at D 5790 and D 5791, was "very fine green sand" ("grey" at D 5806); at D 5790 it was rather "very coarse variegated sand with small proportion of fine sand," while at D 5791 very little bottom material other than "refuse and garbage" was indicated. Except as noted above (D 5806), D 5791 with its "refuse and garbage" bottom returned the least number of specimens, viz., eight, thirteen in one case and twenty or more in each of the

others being recorded for the sandy bottom stations. Three specimens were taken on the fishing grounds by the commercial trawlers, July, 1912. As recorded during the survey the bottom temperature and salinity ranges for the species are respectively 9.4° to 11.1° C and 33.1 to 34.3.

Pagurus capillatus (Benedict)

Eupagurus capillatus Benedict, Proc. U. S. Nat. Mus., **15**, 8, 1892.
Pagurus capillatus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 138, 1900; Rathbun, H. A. E., **10**, 157, pl. 4, fig. 3, 1904.
Pagurus trigonochirus Balss, Abh. der k. Bayer. Akad. Wiss. II, Math.-phys. Klasse, Suppl., 9 Abh., p. 63, 1913 (part).



a *b*

Fig. 85. *Pagurus capillatus*, about natural size; *a*, large (right) cheliped with hairs removed to show spining; *b*, dorsal view of anterior portion, with hands unfortunately foreshortened (U. S. N. M.).

Characters.—Anterior portion of carapace a little longer than wide; median projection of front broadly rounded, lateral projections each armed with an acute submarginal tooth. Eye-stalks long and slender, more than two-thirds as long as the anterior portion of the carapace. Acicle not quite reaching the tip of the eye. Large hand rather sparsely set with sharp stout spines; both hands very hairy, hairs much longer than the spines, often holding mud and dirt. Ambulatory legs stout; dactyls slightly twisted.

Dimensions.—Type, male: length of carapace 26 mm., of anterior portion of carapace 15 mm., width of anterior portion 14 mm., length of larger cheliped 72 mm., of hand 30 mm.

Type Locality.—Norton Sound, Alaska, 12 fathoms.

Distribution.—Arctic Ocean southward through Bering Strait to Kamchatka and California, 3 to 240 fathoms (Rathbun). The single California record for this species is from 240 fathoms, off Santa Cruz.

Remarks.—Balss (1913, p. 63) considers *Pagurus capillatus* (Benedict) identical with *P. trigonocheirus* (Stimpson) (1907, p. 221), basing his remarks upon a specimen of the former received from the U. S. National Museum. However, with his conclusion I am unable to agree, having the type of *P. capillatus* before me. The differences between the two are unmistakable: in *P. capillatus* the antennal scale does not exceed the eye, in *P. trigonocheirus* it does and usually considerably; the eye-stalks of the former are the more slender, the length to breadth being about as 5:1, while in the latter the relation is about 4:1, Balss giving 3.9:1 as an average of five specimens. Moreover the triangular outer face of the smaller hand of *P. trigonocheirus* has its proximal upper and lower margins much bowed out (as is well shown in Stimpson's figure (*Op. cit.*, pl. xxvi, fig. 2), making that face so broadly triangular that its greatest width is contained in its length only twice; in *P. capillatus* the width of the same face of the smaller hand is contained in its length three times. The shape of this triangular outer face of the small hand which in fig. 85, *b* is foreshortened and therefore does not show its proper proportions, is very similar to that of *P. setosus* (p. 136, fig. 88), but relatively not so long as compared to its width; in *P. setosus* the outer face of the smaller hand is about four times as long as wide, in *P. capillatus*, as stated above, three times as long as wide. Further the large hand is more hairy in fresh specimens of *P. capillatus*, and not quite so narrow triangularly as in *P. trigonocheirus*.

Pagurus tanneri (Benedict)

Eupagurus tanneri Benedict, Proc. U. S. Nat. Mus., **15**, 10, 1892.

Pagurus tanneri Holmes, Occas. Papers Calif. Acad. Sci., **7**, 140, 1900; Rathbun, H. A. E., **10**, 158, pl. 4, fig. 7, 1904.

Characters.—Large hand with a prominent ridge beginning at the articulation of the carpus near the inner angle of the palm, running diagonally across it and along the inner portion of the immovable finger; this ridge is joined a little behind the gape of the fingers by another, running across the palm from near its outer proximal angle; these ridges enclose a subtriangular area, either side of which the palm is deeply excavated; subtriangular area armed with five or six short spines; outer depression of hand with a few spiny granules; inner depression unarmed. Outer face of small hand subtriangular and deeply concave; upper margin armed with a single row of spines, a short row of spines from the carpal margin unites with this row, making it appear double for a part of its length in small specimens. Anterior portion of carapace as wide as or wider than long; median projection of front triangular, much longer, and projecting much farther forward than the subacute, broadly triangular lateral teeth, the ends of which are furnished with a terminal spine. Eye-stalks about two-thirds as long as anterior portion of carapace. Acicle exceeding eye-stalk by nearly half its length. Dactyls of ambulatory legs about as long as entire carapace.

Dimensions.—Type, male: length of carapace 31 mm., of anterior portion of carapace 18 mm., width of anterior portion 19 mm., length of larger cheliped 102 mm., of hand 40 mm. Many of the specimens from off California are but half the size of the type.

Type Locality.—Clarence Strait, Alaska, 322 fathoms ("Albatross" station 3077).

Distribution.—From Iliuliuk Harbor, Unalaska, to off San Simeon Bay, California, 50 to 559 fathoms (Rathbun). Off California this species is not known to occur in less than 211 fathoms.

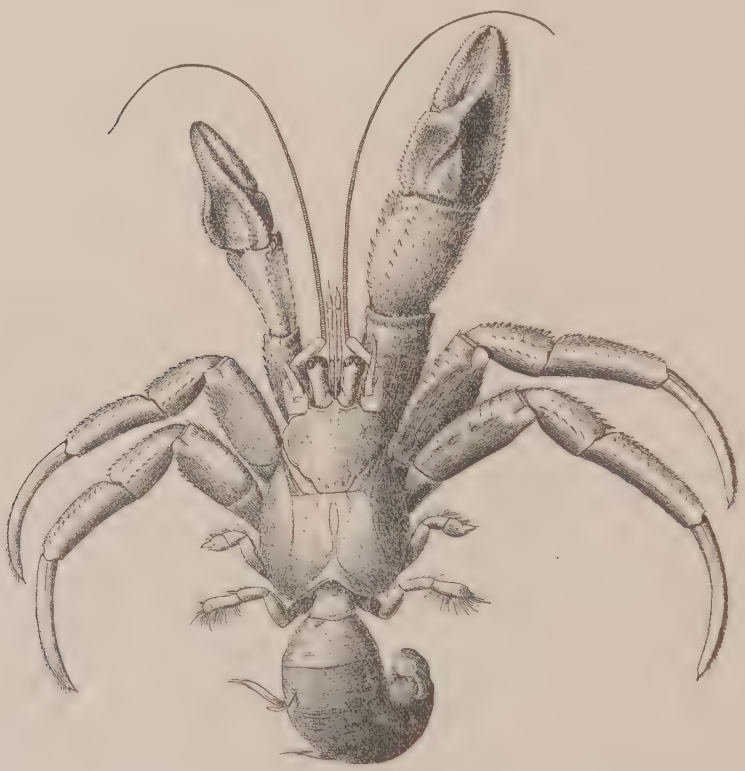


Fig. 86. *Pagurus tanneri*, slightly reduced (U. S. N. M.).

Remarks.—This species is closely related to *P. confragosus* (Benedict, 1892, p. 12), the present known range of which extends from the Bering Sea to off the Columbia River, Oregon, but as Dr. Benedict remarks, "The two species are readily separated by the inner side of the raised triangle of the large hand. In this species [*P. confragosus*] it cuts off the inner depression of the upper surface from the proximal margin of the palm, while in *tanneri* this depression is allowed to reach the margin by a curvature of the ridge."

Pagurus beringanus (Benedict)

Eupagurus beringanus Benedict, Proc. U. S. Nat. Mus., **15**, 17, 1892.
Eupagurus newcombei Benedict, Proc. U. S. Nat. Mus., **15**, 17, 1892.
Pagurus beringanus Rathbun, H. A. E., **10**, 159, pl. 5, fig. 5, 1904.

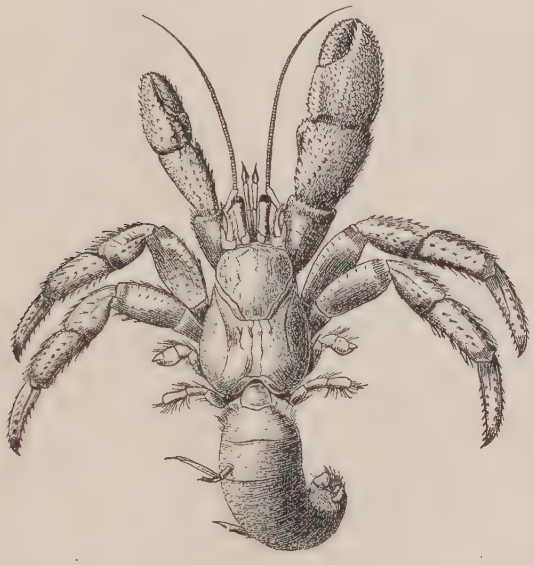


Fig. 87. *Pagurus beringanus*, × 1⅓ (U. S. N. M.).

Characters.—Median projection of front short and low, very blunt, or broadly rounded. Small cheliped with outer face of hand flat-triangular, forming a distinct angle with the smooth though hairy inferior or lower face; carpus with upper or anterior edge with eight or more close set, equidistant spines in a row, occasionally but rarely with a smaller number of spines. Large hand more or less coarsely and irregularly granulate, granules at times tending to become spiniform tubercles, always with a distinct Λ-shaped design of larger granules from base of inner edge of immovable finger to base of palm, inner arm of Λ continued on carpus to its proximal inner angle; immovable finger slightly excavated on upper surface, making tip appear bent upward. Ambulatory legs quite or very hairy.

Dimensions.—Type, male: length of carapace from tip of rostrum to posterior border of carapace, 21 mm., length of larger cheliped 45 mm.

Color.—The distal ends of the joints of the legs are bright red. Both proximal and distal ends of dactyls are red. The light portions of the legs are spotted with red (Benedict).

Type Locality.—Bristol Bay, 12 fathoms ("Albatross" station 3231).

Distribution.—Bering Sea (latitude of Nunivak) southward, along the Aleutian Islands and coast of Alaska to Monterey, California, 5 to 19 fathoms (Rathbun).

Remarks.—*P. newcombei* (Benedict) is included in *P. beringanus*, as it seems to be scarcely distinct. The species varies in the sharpness of the tubercles or spines of the chelipeds (Rathbun).

Pagurus setosus (Benedict)

Eupagurus setosus Benedict, Proc. U. S. Nat. Mus., **15**, 19, 1892.
Pagurus setosus Rathbun, H. A. E., **10**, 159, pl. 5, fig. 1, 1904.

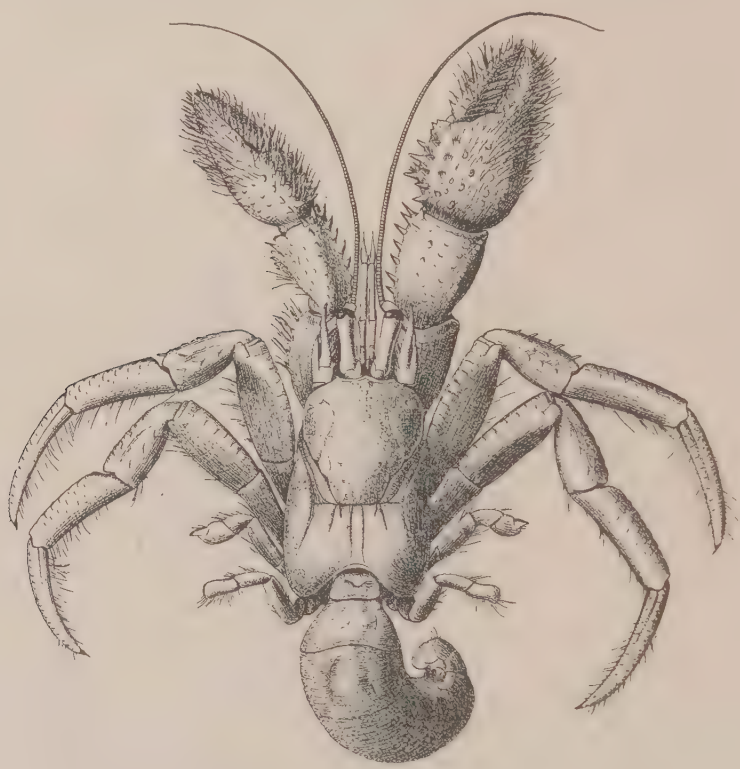


Fig. 88. *Pagurus setosus,* about natural size (U. S. N. M.).

Characters.—Carapace a little longer than broad, median projection of front rounded, a little in advance of the lateral projections, which because of a submarginal spine appear acute. Eye-stalks but slightly more than half as long as anterior portion of carapace. Acicle exceeds eye-stalks by nearly one-fourth its length. Both hands are thickly set with stiff bristles; large hand traversed by seven longitudinal rows of spines, counting marginal rows. Ambulatory legs pubescent, upper margins devoid of spines except on carpus of anterior pair, dactyls not twisted; one-third longer than anterior part of carapace.

Dimensions.—Type, male: length of carapace 21 mm., of anterior portion of carapace 14 mm., width of anterior portion 13 mm., length of larger cheliped 48 mm., of hand 21 mm.

Color.—In formalin the legs are banded with crimson red, hair dirt color (Rathbun).

Type Locality.—Sitka, Alaska.

Distribution.—From Kadiak, Alaska, to off Santa Cruz Island, California, 50 to 266 fathoms.

Remarks.—Except for a slight twisting of the dactyls *P. capillatus* in general appearance is very similar to *P. setosus*, but neither is the large hand proportionally so long nor are its more numerous spines nearly so strong or so distinctly arranged in longitudinal rows. In specimens of the same size the spines on the large hand of *P. capillatus* are only half the size of those of *P. setosus*. The large hand of *P. setosus* is about twice as long as wide, with more depressed fingers than those of *P. capillatus*. The large hand of *P. capillatus* is usually one and a-half times as long as wide, occasionally one and three-fourths times as long as wide. I have seen one specimen only in which the hand was longer, about twice as long as wide; but the characteristic armature of the large hand precludes any confusion as to its identity. Furthermore, the triangular outer face of the small hand of *P. setosus* is more rounded and not so prominently and broadly triangular as that of *P. capillatus*, being about four times as long as wide. In *P. capillatus* the triangular outer face of the small hand is about three times as long as wide.

Pagurus hirsutiusculus (Dana)

Plate 16, figure 4

Bernhardus hirsutiusculus Dana, Proc. Acad. Nat. Sci. Phila., **5**, 70, 1851; Crust. U. S. Expl. Exped., pt. I, p. 443, 1852, pl. 27, fig. 3, 1855.

Pagurus hirsutiusculus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 143, 1900; Rathbun, H. A. E., **10**, 159, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 63, 1916.

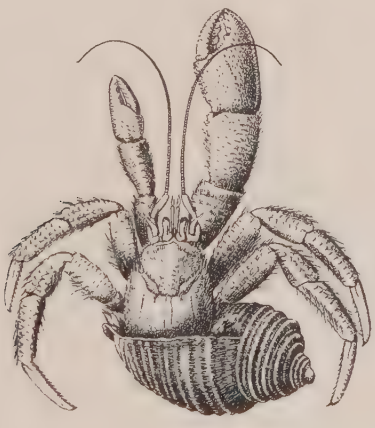


Fig. 89. *Pagurus hirsutiusculus*, × ⅔ (U. S. N. M.).

Characters.—Anterior portion of carapace wider than long, squarish or squat looking; median projection of front triangular, acute. Eye-stalks short and stout. Acicle typically exceeds eye-stalk but frequently falls short of it. Carpus of large cheliped not deeper than wide, inner and lower faces not meeting at a distinct angle. Small hand wider than deep, outer face oblique, triangular, more or less swollen. Carapace and ambulatory legs more or less hairy; dactyls moderately stout, about as long as propodi.

Dimensions.—Type: length 31.8 mm. The carapace of the specimens taken in the Bay averaged between 6 to 9 mm. in length, the longest being about 12 mm. long.

Color.—In formalin body and legs pinkish red. Segments of second and third pairs of feet white at distal ends; dactyli striped longitudinally with pinkish and white (Rathbun). In life antennae are greenish, with alternating large and small golden yellow spots every two or three segments of the flagellum; every segment of first ten spotted; distal segment of antennal peduncle not spotted, plain color. Distal half of propodi of ambulatory legs white, occasionally with slight reddish or pinkish cast, never marked, so far as I have been able to ascertain, with blue; the rest of joint marked with stripes of bluish or greenish brown, corresponding with stripes as the dactyls; dactyls similar to those of *P. samuelis*, either without orange or with a mere trace of it; stripes distinct and more pronounced throughout their length. Large hand often whitish or greenish white.

Type Locality.—Puget Sound.

Distribution.—St. Paul Island, Pribilofs (T. Kincaid), Aleutian Islands to San Diego, California; Siberia, Kamchatka (Rathbun). Japan (Stimpson) (Balss). Low tide to 17 fathoms.

Remarks.—The specimen figured above is very true to type *P. hirsutiusculus* from the Aleutian Islands. I have seen no specimens from California which are quite so large as the one figured or with such great length of acicle (antennal scale) and breadth of carapace. The carapace as figured appears more squat than is often the case. The eye-stalks in the California specimens are proportionately thicker.

The breadth of carapace, thickness of eye-stalks, length of antennal scales and dactyls, general appearance of the larger hand, and color in life, will always serve to distinguish this species from *P. samuelis.*

Biological Survey of San Francisco Bay.—Pagurus hirsutiusculus is the common hermit crab of the bay and is found in littoral and more shoal waters, principally of the middle bay where it is well distributed (see plate 8).

There is only one record from the upper bay, a single specimen dredged in 4 to 24 feet (D 5757), on a fine grayish-black, very muddy sand bottom. Six specimens were obtained at four (10%) of the lower bay stations (D 5723, 5766, 5768, 5781), which, except for D 5766, where three specimens were obtained from a soft mud bottom in 3 to 4 fathoms in Alameda Creek, were dredged on more or less shelly bottoms, at rather widely distributed stations: D 5723, 9½ to 11 fathoms, "black, sticky mud streaked with brown, many shells, clinkers" and abundant ophiurans, off Mission Rock; D 5768, 1 to 3 fathoms, hard shelly bottom, off Alameda; D 5781, 3 to 12 feet in the oyster beds, between Point San Bruno and Point San Mateo.

In the middle bay *Pagurus hirsutiusculus* is recorded from thirteen (18%) of the dredging stations, of which all but three were made at depths varying from 5 feet to 5 fathoms (D 5705, 5708, 5744, 5753, 5755, 5756, 5763, 5764, 5765, 5773, 5778, 5779, 5826). The three deeper stations (D 5705, 5708, 5826) ranged from 7 to 12 fathoms in depth, and at the deepest of these (D 5708), in 10 to 12 fathoms,

ten specimens were taken, the greatest number obtained at any one station. Otherwise the average number of specimens per haul (middle bay only) was one and eight-tenths. Less than one-third (four) of the stations were made on more or less hard bottom, sandy, rocky or both; two hauls were made through the eel grass patches around Angel Island (D 5763, 5764), while seven were either wholly or at least predominantly muddy bottom.

In addition a number of specimens were collected along the rocky shores of the middle bay: two at Point Bonita; six at Sausalito on different occasions; twenty-two at Red Rock, and twenty-five at Richmond, north of the Standard Oil Pier.

The extremes of the correlated temperatures and salinities observed for this species are, respectively, 10.8° to 14.2° C and 17.5 to 31.7. That *Pagurus hirsutiusculus* was not dredged outside is probably due to the combined effect of depth and character of bottom rather than to temperature or salinity, in view of its wide geographic distribution as cited above.

As most of our survey specimens were found inhabiting the shells of *Thais lamellosa* and *Nassa mendica*, it would be interesting to compare their distribution with that of *Pagurus hirsutiusculus* although it should be remembered that hermit crabs sometimes transport shells for considerable distances (Sumner, 1911, p. 153). With the appearance of Packard's *Molluscan Fauna from San Francisco Bay* (1918, pp. 332, 336), I find that the distribution of *Pagurus hirsutiusculus* coincides with the former at eight stations (D 5708, 5723, 5753, 5755, 5773, 5779, 5781, 5826) and the latter at four (D 5705, 5755, 5773, 5779). *Pagurus hirsutiusculus* was also found at three stations from which Packard (1918, p. 332) records *Nassa fossata* (D 5744, 5763?, 5764?).

Pagurus samuelis (Stimpson)

Plate 16, figures 2 and 3

Eupagurus samuelis Stimpson, Proc. Boston Soc. Nat. Hist., **6**, 86, 1857; Ann. Lyc. Nat. Hist. N. Y., **7**, 90, pl. 1, fig. 8, 1859 (1862); Ortmann, Zool. Jahrb., Abt. f. Syst., **6**, 301, pl. 12, fig. 12, 1892. *Pagurus samuelis*, Holmes, Occas. Papers Calif. Acad. Sci., **7**, 144, 1900; Rathbun, H. A. E., **10**, 160, pl. 5, fig. 7, 1904; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 63, 1916.

Characters.—Anterior portion of carapace longer than wide; median projection of front triangular, acute. Eye-stalks only moderately stout. Acicle never exceeding eye-stalk. Carpus of large cheliped not deeper than wide, inner and lower faces not meeting at a distinct angle. Small hand wider than deep; outer

face oblique, triangular, more or less swollen. Carapace and ambulatory legs more or less hairy; dactyls quite short and stout, appearing shorter than propodi, sensibly stouter than in *P. hirsutiusculus.*

Dimensions.—Type: length 19.1 mm. See also *Remarks* below.

Color.—Yellowish (Stimpson). The dactyls are of a bluish color with a longitudinal reddish stripe on the sides; distal ends of the propodi bluish (Holmes). In life antennae are reddish brown; upper surface of distal segment of peduncle with a narrow golden stripe. Distal third of propodi of ambulatory legs blue or white, suffused with blue proximally, the rest of joint marked with stripes of bluish or greenish brown; dactyls blue, becoming white near tip, suffused with pale reddish orange just before corneous claw, with three more or less distinct bluish or greenish red-brown stripes. Large hand usually a dark bluish green, fingers tipped with white, on small hand often edged with orange.

Type Locality.—Tomales Bay, California.

a *b*

Fig. 90. *Pagurus samuelis; a*, ♀, natural size; *b*, ♂, × 1½ (U. S. N. M.).

Distribution.—Humboldt County (Holmes) to San Diego, California (Rathbun). Japan (Stimpson, Ortmann, doubted by Holmes) (Balss).

Remarks.—Figure *a* is that of a female true to type; figure *b*, that of a young male which still partially retains the beaded edge so characteristic of young males, and young and adult females, the original description, and subsequent illustrations. Examination of the extensive collection of this species in the U. S. National Museum showed that the large cheliped in the male becomes with age quite elongate and smoothly granulate comparatively, the beaded outer edge of the hand disappearing completely. The largest *P. samuelis* male I have seen was collected by the Venice Marine Biological Station at the foot of the San Pedro Breakwater, February 21, 1913, and measures 42 mm. from tip of rostrum to end of telson; carapace is 18 mm. long, the anterior portion 7.5 mm., and length of the propodus, carpus, and merus of the large cheliped, taken together, 28 mm.

This is the first instance of sexual dimorphism in adult American hermit crabs of which I am aware. The isolated adult male and female with respect to the character of the large cheliped seem to be two very distinct species; in all other characters, however, there is a close correspondence which precludes any separation. In a lot of over one hundred specimens from Pacific Grove both extremes

and all intergrading forms are represented according to age and development.

A specimen previously reported from Sitka, Alaska, proves to be *P. hirsutiusculus,* and Holmes's record thus becomes its northern limit.

Biological Survey of San Francisco Bay.—Pagurus samuelis is apparently of very exceptional occurrence in San Francisco Bay, very unlike the closely related *P. hirsutiusculus.* The only specimen of *P. samuelis* found was in a lot of twenty-five *P. hirsutiusculus* gathered along the tidal zone of the Richmond shore, just north of the Standard Oil pier.

Pagurus granosimanus (Stimpson)

Eupagurus granosimanus Stimpson, Ann. Lyc. Nat. Hist. N. Y., **7**, 90, 1859 (1862).

Pagurus granosimanus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 146, 1900; Rathbun, H. A. E., **10**, 160, pl. 5, fig. 8, 1904.

Fig. 91. *Pagurus granosimanus,* natural size (U. S. N. M.).

Characters.—Median projection of front short and low, very blunt or broadly rounded. Small cheliped with outer face of hand more or less swollen-triangular, not forming a distinct angle with under side, edge evenly rounded; lower face granulated like the outer, scarcely if at all hairy; six or fewer, more or less separated spines, or, at times, spiniform tubercles on upper or anterior edge of carpus. Large hand more or less evenly and finely granulated, rarely with even an indistinct Λ-shaped design indicated on palm, granules forming it never larger than those covering the rest of the palm. Ambulatory legs sparsely if at all hairy.

Dimensions.—Type, length of carapace 10.9 mm., width of front, measured between bases of outer antennae, 5.6 mm.

Color.—Deep red, with white tubercles on the chelae, and darker red spines on the carpus and merus of chelipeds. Ambulatory legs red, with small white spots;

dactyli with broad white band at middle (Rathbun). Tubercles on underside of meros white. In life the maculations are light blue or yellowish (Stimpson).

Type Locality.—Monterey, California.

Distribution.—Unalaska to Ensenada, Lower California. Beach to 15 fathoms (Rathbun).

Pagurus hemphillii (Benedict)

Eupagurus hemphillii Benedict, Proc. U. S. Nat. Mus., 15, 16, 1892.
Pagurus hemphillii Holmes, Occas. Papers Calif. Acad. Sci., 7, 147, 1900; Rathbun, H. A. E., 10, 160, pl. 5, fig. 9, 1904.

Fig. 92. *Pagurus hemphillii*, type ♂, natural size (U. S. N. M.).

Characters.—Carpus of large cheliped with a very deep, flat, perpendicular inner face, forming a sharply distinct angle with the inferior or lower face, depth of carpus greater than width. Base of immovable finger of large hand somewhat excavated above, with a quite evident though evenly rounded and not abrupt depression near the outer margin, causing the finger to appear bent upward. Small hand very much compressed laterally, not swollen, deeper than wide, sides (inner and outer faces) subparallel. Anterior portion of carapace very long, about one-third longer than wide, not hairy, smooth and shining; median projection of front triangular, acute. Acicle shorter than the eye-stalks; eye-stalks comparatively long and slender. Ambulatory legs scarcely if at all hairy.

Dimensions.—Type, male: length from tip of rostrum to end of telson 42 mm., length of carapace 17 mm. This is the largest specimen seen; there are in the U. S. National Museum two other specimens, measuring in length respectively 23 and 25 mm.

Color.—In alcohol bright red, the tips of the dactyls light colored (Benedict). Holmes says, "there is a well marked light spot on the sides of the dactyls near the end."

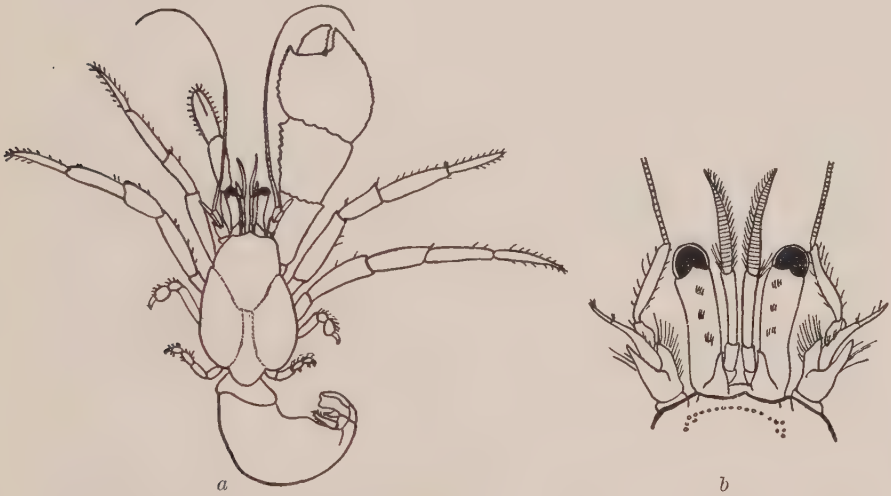
Type Locality.—Monterey, California.

Distribution.—British Columbia to Monterey, California.

Pagurus californiensis (Benedict)

Eupagurus californiensis Benedict, Proc. U. S. Nat. Mus., **15**, 21, 1892; Faxon, Mem. Mus. Comp. Zool. Harvard College, **18**, 55, pl. 11, fig. 2–2*e*, 1895.

Pagurus californiensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 149, 1900; Rathbun, H. A. E., **10**, 161, 1904.



a *b*

Fig. 93. *Pagurus californiensis*, ♂, × 2; *a*, dorsal view; *b*, anterior portion of carapace, enlarged (after Faxon).

Characters.—Small hand very feeble, less than one-third the greatest width of the palm of larger hand. Large hand more or less suborbicular, feebly granulated on palm. Anterior portion of carapace about as broad as long, median projection of front triangular, acute. Eye-stalks moderately long and slender, about three-fourths as long as anterior portion of carapace. Acicle not exceeding eye-stalks. Ambulatory legs glossy, nearly smooth; from upper distal margin of carpus a small spine extends forward over propodus; dactyls thin, pubescent, not twisted, but little curved, spinulous below, and exceeding length of the propodi.

Dimensions.—Two male types: length 26 mm. and 20 mm., respectively.

Color.—Alcoholic specimens nearly orange in color, the ambulatory legs crossed by bands of a lighter color. There is a band of lighter color near the middle of the ocular peduncles (Holmes).

Type Locality.—California.

Distribution.—From Monterey Bay or Santa Catalina Island, California, to Gulf of California, 8 to 58 fathoms.

Genus **Pylopagurus** Milne Edwards and Bouvier

Abdomen with paired appendages, other than the uropods on the first abdominal segment in the female only. External maxillipeds widely separated at base; exopodites of all three pairs of maxillipeds flagellate. Chelipeds dissimilar and unequal, the right vastly the larger; large hand more or less operculiform, greater part of upper surface transversely concave, trough-shaped, or discoidal with raised margins; bent at an angle to the wrist. Fourth pair of legs subchelate.

Pylopagurus minimus (Holmes)

Plate 16, figures 1*a*, 1*b*, and 1*c*

Pagurus minimus Holmes, Occas. Papers Calif. Acad. Sci., 7, 145, 1900.

Characters.—Median projection of front triangular, acute, lateral ones rounded; anterior portion of carapace about as wide as long. Chelipeds pubescent; large hand oblong, widening distally to a short distance beyond the base of the movable finger; base of the hand armed with anteriorly inclined spines, strongly convex longitudinally, giving hand the appearance of being bent downward; fixed finger broad, outer edge evenly rounded, sharp, upturned, and armed with anteriorly directed spines, the upper surface smooth and concave; movable finger broad, widest a little beyond its articulation, outer margin sharp, spiny, evenly curved, upper surface nearly smooth and concave; inner margin of both fingers furnished with large, white, tubercular teeth; small hand narrow, rounded, fingers longer than palm. Dactyls of ambulatory legs slender, curved, tapering from the base, spiny below, and longer than the propodi.

Dimensions.—Type, female: length 10 mm.

Color.—General color reddish, with spots of darker red, larger cheliped a darker red than the rest of the body, especially at the distal end; ocular peduncles with a median, transverse, light colored band (Holmes), described from a single female specimen carrying numerous pale green eggs.

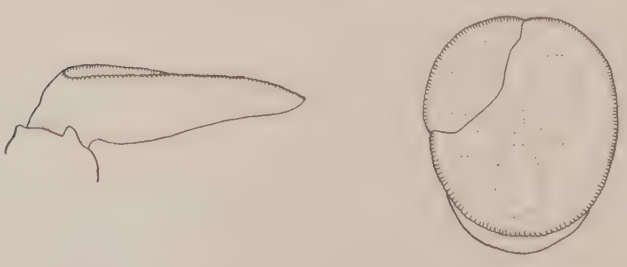
Type Locality.—Off San Diego, dredged in 30 fathoms (Holmes).

Distribution.—Skidegate, Queen Charlotte Sound, British Columbia; San Francisco, Monterey Bay, Laguna Beach, and San Diego, California, 15 to 35 fathoms.

Remarks.—This species is best distinguished by the character of the larger hand, which is convex at the narrow base, both longitudinally and transversely, while the distal portion is nearly smooth, longitudinally straight, but transversely concave (Holmes). Has been found in worm tubes (Benedict) and in *Dentalium* ("tooth") shells between the Farallones and Golden Gate.

Biological Survey of San Francisco Bay.—A single specimen of *Pylopagurus minimus* was dredged at D 5790, 33 to 35 fathoms, in company with *Pagurus ochotensis*, and *Paguristes bakeri*.

Pylopagurus holmesi sp. nov.



a *b*

Fig. 94. *Pylopagurus holmesi*, ♂, large hand; *a*, external-lateral view, × 6½; *b*, view of flat upper face, slightly smaller.

Description.—Median projection of front narrow, triangular, acute, about twice as long as wide at the base and reaching well beyond the middle of the narrow, lanceolate eye scales, i.e., to or nearly to their acutely pointed tips; lateral projections of front but slightly in advance of the base of the median projection, rounded; anterior portion of the carapace about as wide as long, or a little less. Eye-stalks compressed, scarcely if at all widening distally; reaching about to the middle of the terminal segment of the antennular peduncle when extended, and falling a little short of the antennal peduncle but slightly exceeding the antennal scale. Chelipeds not hairy, greater part of upper surface of large hand discoidal, widest at level of the bases of the fingers, with raised, finely incised, denticulate margins, which posteriorly separate discoidal face from a narrow, transversely and longitudinally convex basal (proximal) portion that fills in the angle which the upper surface makes with the wrist, or carpus; granules on upper face of carpus not confluent, distinct; the fingers are wide and flattened, widest distal to articulation of movable finger, outer margins but continuations of the denticulate raised outer margins of palm; small hand narrow, rounded, palm and fingers subequal, fingers slightly gaping. Dactyls of ambulatory legs strongly compressed, spinulous above and below, and terminating in a long, corneous claw.

Dimensions.—Type, male (Cat. No. 53330, U. S. N. M.): length over all 30 mm., of carapace and rostrum 7.5 mm., of large hand 7.5 mm., of discoidal upper face of hand 6 mm., width of same 5 mm.

Type Locality.—Santa Catalina Island, California; taken by the Venice Marine Biological Station near Catalina Harbor (station T 156).

Distribution.—From Santa Catalina Island, and San Pedro to San Diego, California, 10 to 30 fathoms.

Remarks.—This species, though remarkably like *P. discoidalis* (Milne Edwards) (see Milne Edwards and Bouvier, Mem. Mus. Comp. Zool., **14**, 18, 76, pl. vi, figs. 7–14) from the West Indian region, differs sufficiently to be considered a distinct species. The rostriform median projection of the carapace of *P. discoidalis* is broadly triangular, about as wide at the base as long, the denticulations of the raised margins of the upper face of the large hand are less incised, rather more crenulate than denticulate; the granules on the carpus of the large cheliped are more or less confluent, forming transverse scabrous lines or ridges rather than rows of distinct granules. In many of the specimens of *P. discoidalis* the upper face of the hand is as much as one and a-half times as long as wide, with the tip of the immovable finger extending slightly beyond that of the movable one. A number of specimens have broader, rounder hands, with subequal fingers, as have all the specimens of *P. holmesi* which I have examined.

Genus **Parapagurus** Smith

Abdomen with paired appendages other than the uropods on the first and second segments in the male only. External maxillipeds widely separated at base; exopodite of first pair of maxillipeds non-flagellate. Chelipeds dissimilar and unequal, the right being vastly the larger. Fourth pair of legs subchelate. In the female there is only one oviduct, which opens on the coxa of the third left thoracic leg.

Parapagurus mertensii (Brandt)

Plate 16, figure 5

Pagurus mertensii Brandt, *in* Middendorff, Reise in den äussersten Norden und Osten Sibiriens, Bd. II, Zool., Th. I, p. 112, 1851.

Parapagurus mertensii Holmes, Occas. Papers Calif. Acad. Sci., 7, 155, 1900; Rathbun, H. A. E., 10, 162, pl. 5, fig. 6, 1904.

Characters.—Median projection of front prominent, somewhat elongate, tip rounded, sides subparallel, lateral projections small; anterior portion of carapace about as wide as long. Eye-stalks short, about one-half length of anterior portion of carapace. Chelipeds pubescent, spiny, very unequal; right cheliped very large, carpus long, inner and outer margins spiny, convex upper surface armed with two rows of short spines, hand long, narrow, dorso-ventrally flattened, and bent inward at a slight angle to the carpus, rounded upper surface with small, subserially arranged granules which become more prominent on the fingers, inner and outer margins sharp, granulo-denticulate and parallel; left cheliped long, slender and attenuate, carpus subcylindrical, with three rows of spines on the upper surface, hand narrow, much longer than the carpus, palm very short, fingers long, narrow, and curved downward. Dactyls of ambulatory legs exceedingly long and slender, armed below with numerous spines.

Dimensions.—Type: length of carapace 19.1 mm., width 14.8 mm.

Type Locality.—Kamchatka.

Distribution.—Kadiak Island, Alaska, to off San Nicolas Island, California, 77 to 266 fathoms.

Remarks.—This species affords one of those curious cases of commensalism with colonies of hydroids sometimes found among deep sea pagurids. The colony of hydroids covering the shell in which the crab lives forms a membranous growth which extends beyond the boundary of the shell and in course of time, according to Dr. Benedict, causes the shell to disappear, leaving its inhabitant with a membranous instead of a calcareous domicile. In the specimen which I have the covering is partly formed by the tip of a broken shell but mainly by an extension of the membranous growth formed by the colony of hydroids. This arrangement certainly affords the crab the advantage of allowing it to grow without having to undergo the troublesome experience of changing lodgings (Holmes).

Family Lithodidae

Body crab-like. Abdomen more or less firm, in part at least; often segmented, bent under thorax; no tail-fan developed, uropods absent. Carapace quite firm all over. First pair of legs chelate; fourth pair like the third; fifth pair very small and folded under the carapace, making it appear superficially that the members of this family have but four pairs of legs, a character which easily distinguishes it from any other family of Decapods.

Key to the California Genera of the Lithodidae

I. Abdomen soft, more or less loosely inflexed, unsegmented; at most only basal (second), and two terminal segments stiffened by thin calcareous plates; reinforcement of basal segment usually consisting of a pair of narrow marginal plates and a pair of lateral plates, between which there may be a median plate; abdomen occasionally armed with calcified granules or short spines.

A. Carapace not spiny on upper surface; rostrum short, simple, triangular.
1. Carapace and legs much flattened and more or less hairy or pubescent; lateral margins of carapace with a few small teeth or spines. Anterior margin of ambulatory legs deeply incised, incisions hidden by hairiness of legs. (Not known south of Monterey.)
Hapalogaster, p. 148.
2. Carapace not so flattened, moderately convex, somewhat roughened, granular on upper surface, slightly setose but not hairy; lateral margins unarmed. Ambulatory legs subcylindrical, very sparsely haired. (Not known south of Pacific Grove.)
Oedignathus, p. 150.

B. Carapace distinctly flattened and covered with numerous subequal spines; rostrum terminated by strong spines. Legs spiny, with long hairs arising from tip of spines. (Not known south of Monterey.)
Acantholithodes, p. 152.

II. Abdomen segmented, and subdivided into more or less well calcified plates, which are usually applied quite closely to the thoracic sternum; basal (second) segment always provided with a pair of marginal and a pair of lateral plates, and a median plate; plates either separated by sutures or more or less completely fused with one another; abdomen quite smooth or armed with more or less prominent tubercles or spines; occasionally abdominal plates have a central membranous area.

A. Abdominal plates with characteristic raised and rounded papillated edges enclosing a central membranous area; median and lateral plates of basal (second) segment distinct. Ambulatory legs about as long as greatest width of carapace. Outline of carapace practically forming an equilateral triangle; upper surface with two deep pits within a triangular excavated area, surrounded by rounded papillated tubercles. (Not known south of Monterey.)
Phyllolithodes, p. 153.

B. Abdominal plates without a central membranous area.
1. Ambulatory legs shorter than the greatest width of the carapace, usually much shorter.
a. Carapace broadly oval, convex, smooth, and produced into lateral expansions, which completely conceal the ambulatory legs, forming a large expanded dorsal shield. Basal (second) abdominal segment entire. (Not known south of Monterey.)
Cryptolithodes, p. 154.
b. Carapace not so produced, more crab-like in appearance, more or less prominently tuberculated.
i. Outline of carapace practically forming an equilateral triangle; with a deep semilunar fossa separating the smooth hemispherical cardiac region from the other more or less coarsely tuberculated regions of the carapace. Plates of basal (second) abdominal segment distinct. (Not known south of Crescent City.)
Rhinolithodes, p. 157.
ii. Outline of carapace roughly pentagonal or hexagonal, very convex, roughened, with many close set, short tubercles and fewer more or less prominent subconical tubercles. Basal (second) abdominal segment entire. (Not known south of Monterey.)
Lopholithodes, p. 155.

2. Ambulatory legs considerably longer than greatest width of carapace, often about twice or nearly twice as long.
   a. Abdomen well calcified, median row of plates of segments three to five replaced by a membranous area well armored with numerous spiny, calcified nodules. Carapace more or less strongly spined, not less than four sharp-pointed spines on gastric region.
      i. Plates of basal (second) abdominal segment distinct, separated by sutures. (Known only from 155 + fathoms.) *Paralithodes*, p. 160.
      ii. Plates of basal (second) abdominal segment more or less fused, either completely so, or with median and lateral or lateral and marginal plates fused together. (Known only from 301 + fathoms.) *Lithodes*, p. 161.
   b. Abdomen more or less leathery, median row of plates of segments three to five distinct and separate; basal (second) segment entire. Upper surface of carapace more or less tuberculated or covered with numerous short, blunt spines, only one sharp spine on gastric region. (Known only from 625 + fathoms.) *Paralomis*, p. 158.

The genera of this family are for convenience divided into two groups, based primarily on the character of the abdomen, corresponding to the major divisions of the above key (Brandt, 1850, p. 259; Bouvier, 1896*a*, p. 16). The apparent basal segment of the abdomen is in reality the second, while the last, or terminal (ultimate) segment, or plate represents the telson.

I. Abdomen soft, more or less loosely inflexed, unsegmented; at most only basal (second) and two terminal segments, stiffened by thin calcareous plates; reinforcement of basal segment usually consisting of a pair of narrow marginal plates and a pair of lateral plates, between which there may be a median plate; abdomen occasionally armed with calcified granules or short spines. Carapace more or less distinctly flattened, occasionally slightly but never strongly convex, lyrate or roughly quadrilateral; front moderately broad; rostrum scarcely if at all exceeding the eye-stalks. (Group II, p. 153.)

Genus **Hapalogaster** Brandt

Carapace, chelipeds, and ambulatory legs much flattened and more or less hairy or pubescent; lateral margins of carapace with a few small teeth or spines. Basal (second) abdominal segment with a thin, transverse, calcareous lateral plate on either side; a pair of marginal plates present but small and inconspicuous.

Key to the California Species of Hapalogaster

I. Hand of larger cheliped densely covered with short hair, somewhat roughened or granulated at the insertions of the hair, not spinous or tuberculated except for one or more small calcareous tubercles on inner face, behind articulation of the dactyl. Lateral margins of carapace with not more than two small teeth on each side. (From Cape Mendocino to Monterey.) *cavicauda*, p. 149.

II. Hand of larger cheliped finely pubescent and armed with three longitudinal rows of spines; a row of small spines on the inner edge and two rows of larger spines on the outer surface of the hand, with a broad smooth interval between them. Lateral margins of the carapace with from four to six teeth on each side. (Not known south of Humboldt Bay.)

grebnitzkii, p. 150.

Hapalogaster cavicauda Stimpson

Plate 29, figure 1

Hapalogaster cavicauda Stimpson, Ann. Lyc. Nat. Hist. N. Y., **7**, 81, pl. 1, fig. 7, 1859 (1862); Bouvier, Ann. Sci. Nat. (7), **18**, 166, pl. 12, fig. 29, 1895; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 113, 1900.

a *b*

Fig. 95. *Hapalogaster cavicauda; a*, dorsal view of carapace, ♂ (after Bouvier); *b*, ♂, natural size (after Stimpson).

Characters.—Body and legs densely covered with short hair. Carapace nearly smooth but roughened or granulated at the insertions of the hairs. The portion of the anterolateral margin of the carapace in front of the cervical groove is convex, sublaminate, edentate, and separated from the portion behind by an incision; two marginal teeth at the origin of the sutures. Anterior margins of ambulatory legs deeply incised, forming four or five closely approximated teeth on each of the larger joints; the incisions are hidden by the hairiness of the legs. Hand of larger cheliped with one or more small, calcareous tubercles on inner face only, behind articulation of the dactyl. The calcareous plates on the basal (second) segment are widely separated by a membranous interval, in which there is no median plate; left side of abdomen of female is coriaceous and segmentally incised.

Dimensions.—Type: length of carapace 18.3 mm., width 21.1 mm.

Type Locality.—Monterey, California. Common under rocks at low tide.

Distribution.—From Cape Mendocino to San Clemente Island, California.

Hapalogaster grebnitzkii Schalfeew

Plate 29, figure 2

Hapalogaster grebnitzkii Schalfeew, Mélanges Biol. **13**, 329, figs. 3*a*–3*b*, Bull. Acad. Imp. Sci. St. Petersb., **35**, 335, 1892; Bouvier, Ann. Sci. Nat. (8), **1**, 19, 1896; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 115, 1900; Rathbun, H. A. E., **10**, 163, 1904.

Fig. 96. *Hapalogaster grebnitzkii*, dorsal view of carapace, reduced (after Schalfeew).

Characters.—Carapace and legs finely pubescent; margin of carapace behind the cervical groove armed with five spines, which decrease in size posteriorly. Legs armed with setose spines. Hand of right, or larger cheliped armed with two rows of spines on the outer surface and a row of small spines on the inner edge; there is a broad smooth unarmed interval between the two rows of spines on the outer surface. Abdomen as in *H. cavicauda.*

Dimensions.—Largest specimen of type lot: length of carapace 18 mm., width 18.5 mm.

Type Localities.—Bering Islands and Kadiak, Alaska.

Distribution.—From Bering Sea off the Pribilofs and Cape Newenham southward, along the Aleutian Islands to Sitka, Alaska; Bering Island; Humboldt Bay, California.

Remarks.—Bouvier thinks that this species is but a variety of *H. mertensii* Brandt, which ranges from Atka, one of the Aleutian Islands, eastward and southward to Puget Sound. In view of their overlapping ranges this might well be the case. The chief difference between them is in the number of longitudinal rows of spines on the right hand: *H. grebnitzkii* has three, while *H. mertensii* has four. Holmes notes still another difference, viz., the absence of a spine behind the gape of the fingers of the smaller hand of *H. grebnitzkii;* but for this difference the small hands of each would be spined alike.

Genus **Oedignathus** Benedict

Carapace moderately convex, somewhat roughened, granular on upper surface, slightly setose, but not hairy; lateral margins unarmed. Ambulatory legs subcylindrical, very sparsely haired. Abdomen much as in *Hapalogaster.*

Oedignathus inermis (Stimpson)

Plate 19, figure 1

Hapalogaster inermis Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 243, 1860 (1862).

Hapalogaster brandti Schalfeew, Mélang. Biol., 13, 330, figs. 1, 5*b*, Bull. Acad. Imp. Sci. St. Petersb., 35, 336, 1892.

Oedignathus inermis Holmes, Occas. Papers Calif. Acad. Sci., 7, 119, 1900.

Oedignathus brandti Holmes, *ibid.*, 7, 118, pl. 1, figs. 17–20, 1900.

Oedignathus inermis Rathbun, H. A. E., 10, 163, 1904.

Dermaturus inermis Balss, Abh. der k. Bayer. Akad. Wiss., II, Math.-phys. Klasse, Suppl., 9 Abh., p. 71, 1913.

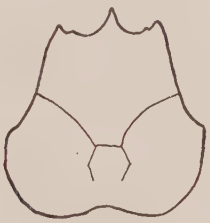


Fig. 97. *Oedignathus inermis,* outline of carapace (after Holmes).

Characters.—Carapace more or less completely covered with flat scale-like plates or minute squamae, which are setose along the anterior margin. Chelipeds very unequal and covered with low, granulated, wart-like tubercles; hand of larger cheliped large and swollen, fingers somewhat gaping at the base, the tips excavated within. Calcareous plates on the two terminal abdominal segments inconspicuous; the margin of the left side of the abdomen in the female only is somewhat hardened and segmentally incised.

Dimensions.—Type: length of carapace 10 mm., width posteriorly 9.7 mm. Of a specimen examined by Holmes, length of carapace from tip of the rostrum to posterior emargination 15.5 mm., width 15.5 mm., length of large cheliped 40 mm., length of small cheliped 28 mm.

Type Locality.—Puget Sound.

Distribution.—Unalaska to Pacific Grove, California (Rathbun). Japan (Balss).

Remarks.—Miss Rathbun has very little doubt concerning the identity of Schalfeew's species with that of Stimpson. She remarks that Stimpson's type was smaller than any examples in the National Museum.

Biological Survey of San Francisco Bay.—There are two specimens of *Oedignathus inermis* in the survey collection: a very small one with a carapace about 3 mm. long, taken from between the tide levels at Point Bonita, and a larger one with a carapace 25 mm. in length, which unfortunately bears no label but which was probably obtained at or near the same locality.

Genus **Acantholithodes** Holmes

Carapace flattened and hispid with numerous short setose spines. Chelipeds and ambulatory legs armed with numerous similar though larger and stronger spines. Basal (second) and two terminal abdominal segments stiffened by thin calcareous plates, remainder of abdomen membranous.

Acantholithodes hispidus (Stimpson)

Plate 19, figure 2

Dermaturus hispidus Stimpson, Ann. Lyc. Nat. Hist. N. Y., **7**, 242, 1860; Bouvier, Ann. Sci. Nat. (7), **18**, 174, pl. 11, figs. 3, 16, pl. 12, figs. 2, 16, 31, 1895.

Acantholithodes hispidus Holmes, Proc. Calif. Acad. Sci. (2), **4**, 575, 1895; Occas. Papers Calif. Acad. Sci., **7**, 120, 1900.

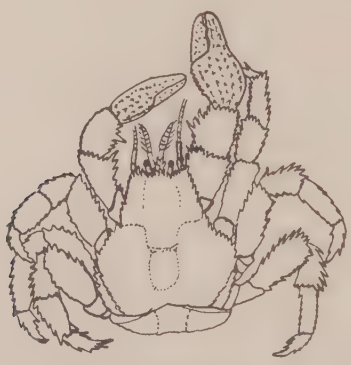


Fig. 98. *Acantholithodes hispidus*, outline of ♂ (after Bouvier).

Characters.—Rostrum prominent and terminated by strong spines. Branchial regions of carapace with a slight depressed area; between cardiac and gastric regions there is quite a sharp, narrow cleft. Abdomen, short, broad, and soft; integument spiny, spines not so large as on carapace; on basal (second) segment a median plate, two wide lateral plates and two narrow marginal ones; the plate on the penultimate segment is oblong; the last one, representing the telson, is small, rounded, and about as long as wide.

Dimensions.—Type, female: length of carapace 21.6 mm., width anteriorly 10.9 mm., posteriorly 22.9 mm. Of a specimen examined by Holmes, length of carapace from tip of rostrum 58 mm., width of carapace 56 mm.

Color.—Fingers bright red, with white tuberculiform teeth, and black horny tips, rest of body yellow, except hands, which are suffused with tinge of red from fingers (Stimpson).

Type Locality.—Monterey Bay, California, from stomachs of fishes.

Distribution.—Off Moorovskoy Bay, Alaska ("Albatross" station 3319), to Monterey, California, to a depth of 73 fathoms.

Biological Survey of San Francisco Bay.—There is one specimen of *Acantholithodes hispidus* in the collection without a label, but it

was undoubtedly taken along with *Randallia ornata* in course of several experimental trials with a 40-foot otter-trawl in 10 to 30 fathoms outside of Golden Gate, April 6, 1914.

II. Abdomen segmented and subdivided into more or less well calcified plates which are usually applied quite closely to the thoracic sternum; basal (second) segment always provided with a pair of marginal and a pair of lateral plates, and a median plate; plates either separated by sutures or more or less completely fused with one another; abdomen quite smooth or armed with more or less prominent tubercles or spines; occasionally abdominal plates have a central membranous area. Carapace quite strongly convex, at least in the gastric region; roughly triangular, pentagonal or hexagonal; front usually more or less narrow; rostrum usually exceeding the eye-stalks. (Group I, p. 148.)

Genus **Phyllolithodes** Brandt

Carapace triangular, provided with rounded tubercles, which surround an excavated area on the dorsal surface; lateral margins armed with spines. Abdominal plates with a central membranous area.

Phyllolithodes papillosus Brandt

Plate 22, figure 2

Phyllolithodes papillosus Brandt, Bull. Phys. Math. Acad. St. Petersb., **7**, 175, 1849; Bouvier, Ann. Sci. Nat. (7), **18**, 174, pl. 11, fig. 12, pl. 12, figs. 14, 25, pl. 13, fig. 1, 1895; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 122, 1900; Rathbun, H. A. E., **10**, 164, 1904.

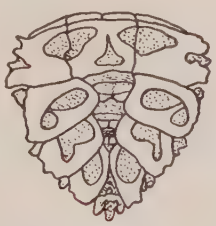


Fig. 99. *Phyllolithodes papillosus*, ventral view of abdomen, ♂ (after Bouvier).

Characters.—Carapace with two deep pits within triangular area on dorsal surface. Rostrum prominent, ending in two tuberculiform horns, below with a subacute median spine. Chelipeds and ambulatory legs thickly covered with long, flattened, obtusely ending papillated spines, somewhat like narrow, flattened plates in appearance; these are largest on the merus and carpus, diminishing toward the tip. Abdomen furnished with calcareous plates, with distinct, characteristic raised and rounded papillated edges, within which there is a central membranous area; median and lateral plates separated by a suture.

Dimensions.—Type: length of carapace 46.6 to 48.7 mm., width 42.4 mm.

Type Locality.—Kadiak Island, Alaska.

Distribution.—Unalaska to Monterey, California. To a depth of at least 16 fathoms (Rathbun).

Genus **Cryptolithodes** Brandt

Carapace transverse, broadly oval, nearly smooth, high in the middle, and laterally produced into wide expansions which completely conceal the ambulatory legs, forming a large, expanded dorsal shield. Abdomen flattened, triangular, fitting neatly into a depression of the sternum; behind the entire basal (second) segment the abdomen bends abruptly; the three following segments are divided into a median row of plates, with a series of lateral plates on either side; penultimate segment is devoid of lateral plates, and conceals the minute triangular telson.

Key to the California Species of Cryptolithodes

I. Hands tuberculated. Rostrum narrowing distally, end rounded, without distinct anterolateral angles. Abdomen crossed by transverse ridges. (Not known south of Monterey.)

typicus, p. 154.

II. Hands smooth. Rostrum widened toward distal end, which is transverse, with distinct antero-lateral angles, and often but not always with a small median tooth. Abdomen smooth. (Not known south of Pacific Grove.)

sitkensis, p. 155.

Cryptolithodes typicus Brandt

Plate 20, figures 1 and 2

Cryptolithodes typicus Brandt, Bull. Phys.-Math. Acad. St. Petersb., **7**, 185, 1849, **11**, 254, 1853; Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 572, pl. 19, 1857; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 124, 1900; Rathbun, H. A. E., **10**, 164, 1904; Way, Puget Sd. Mar. Sta. Publ., **1**, 352, fig. 5, 1917.

Characters.—Carapace about twice as wide as long, with lateral expansions rarely advanced even as far as half the length of the rostrum, orbital sinus never very deep, never as deep as half the length of the rostrum. Rostrum narrowing distally, end rounded, no distinct anterolateral angle. Hands tuberculated, with several tuberculous ridges on the outer surface. Abdomen crossed by transverse ridges, lateral plates with more or less raised margins.

Dimensions.—Type: length 33.9 mm., width 48.7 mm.

Color.—Blackish brown on dorsal side, light gray on ventral (Way). Several specimens preserved in the U. S. National Museum, greenish in alcohol.

Type Locality.—Northern California.

Distribution.—Unalaska, Alaska, to Monterey, California, to a depth of 7 fathoms.

Cryptolithodes sitchensis Brandt

Plate 20, figures 3 and 4

Cryptolithodes sitchensis Brandt, Bull. Phys.-Math. Acad. Imp. Sci. St. Petersb., **11**, 254, 1853; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 125, pl. 2, figs. 21–25, 1900.

Fig. 100. *Cryptolithodes sitchensis,* natural size.

Characters.—Carapace usually about one and two-thirds as wide as long, with lateral expansions produced forward almost the entire length of the rostrum, at least two-thirds its length, forming a large, deep, rounded orbital sinus on either side. Rostrum widened toward distal end, which is transverse, with distinct anterolateral angles and often, but not always, with a small median tooth. Hands smooth, with but a single, usually very faint rounded, longitudinal ridge a little below the middle of the outer surface. Abdomen smooth, lateral plates flat.

Dimensions.—Type: length of carapace 23.9 mm., greater width 57.2 mm. Of specimens examined by Holmes: males, length of carapace 16 to 47 mm., width 23 to 64 mm.; females, length of carapace 25 to 36.5 mm., width 36 to 49.5 mm. Length of carapace of specimen listed below 40 mm.

Color.—Males, in fresh condition, uniform bright red color; females, red but with a purplish tinge, irregularly marked with blotches of a lighter color (Holmes). Also reddish in alcohol.

Type Locality.—Sitka, Alaska.

Distribution.—From Sitka, Alaska, to Pacific Grove, California.

Remarks.—The specimen figured is one given me by Mr. D. L. Emery, who collected it at Tunitas Glen, July 4, 1913.

Genus **Lopholithodes** Brandt

Carapace broad, pentagonal or hexagonal above, with margins and upper surface armed with setose tubercles and fewer, more or less prominent, subconical ones; a peculiar smooth, wart-like prominence occurs on either side of the median gastric area. Ambulatory legs short, tuberculated, and capable of being folded under the carapace. Basal (second) segment of abdomen entire, the three following segments with lateral plates, also with small marginal plates on one or both sides; penultimate joint devoid of lateral plates, telson very small.

Key to California Species of Lopholithodes

I. Tubercles of chelipeds and ambulatory legs spiniform; carpus of chelipeds with outer edge excavated, forming a smooth, deep, rounded sinus, which when approximated to the shallower corresponding sinus on the anterior edge of the first pair of ambulatory legs forms a striking, smooth, nearly circular hole, or foramen.
foraminatus, p. 157.

II. Tubercles on legs generally rounded, blunt, and knob-like; carpus of chelipeds without a smooth, deep, rounded sinus on outer edge. (Not known south of Monterey.)
mandtii, p. 156.

Lopholithodes mandtii Brandt

Plate 21, figure 1

Lopholithodes mandtii Brandt, Bull. Phys.-Math. Acad. Imp. Sci. St. Petersb., **7**, 174, 1849.

Echinocerus cibarius White, Proc. Zool. Soc. London, **47**, pls. 2, 3, 1848: Bouvier, Ann. Sci. Nat. (7), **18**, 184, pl. 11, fig. 13, pl. 12, 1895.

Lopholithodes mandtii Holmes, Occas. Papers Calif. Acad. Sci., **7**, 128, 1900; Way, Puget Sd. Mar. Sta. Publ., **1**, 356, fig. 12, 1917.

Fig. 101. *Lopholithodes mandtii*, ventral view of abdomen, ♀ (after Bouvier).

Characters.—Carapace strongly convex; gastric, cardiac, and branchial regions each with a prominent elongate, subconical tubercle, subacute on gastric area, blunt and rounded on others; anterolateral margin armed with a variable number of about eight, prominent, blunt spines and several smaller spines; a large knob-like prominence at each posterolateral angle, separated from the last anterolateral spine by a conspicuous sinus, two similar smaller prominences on either side of the middle of posterior margin of carapace. Rostrum short and consisting of a strong subconical tubercle, above the base of which is a knob bearing two lateral tubercles with generally a tubercle above, and behind the notch between them. Tubercles on legs generally rounded, blunt, and knob-like. Basal abdominal segment is strongly concave behind, especially in the female, and at nearly right angles to the carapace; there are two very prominent tubercles near the middle and several smaller ones on the margins, the remaining segments studded with numerous subconical tubercles.

Dimensions.—Type: length of carapace 152.4 to 177.8 mm., width about 177.8 to 203.2 mm.

Color.—Very brilliant, scarlet or orange, with bright purple markings particularly on ventral part of the body and the spines on the legs (Way).

Type Locality.—Sitka, Alaska.

Distribution.—Sitka, Alaska, to Monterey, California.

Lopholithodes foraminatus (Stimpson)

Plate 21, figure 2

Echinocerus foraminatus Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 79, 1859 (1862); Newcombe, Bull. Nat. Hist. Soc. Brit. Col., p. 27, pl. 3, 1893.
Lopholithodes foraminatus Holmes, Occas. Papers Calif. Acad. Sci., 7, 130, 1900.

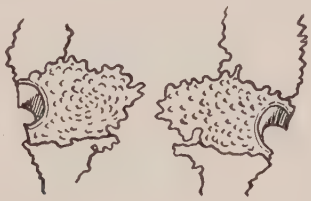


Fig. 102. *Lopholithodes foraminatus,* dorsal view of carpus of chelipeds, ♂, × nearly ¼ (after Newcombe).

Characters.—Carapace depressed; gastric region elevated, furnished with a short, sharp, conical tubercle near the middle and a group of smaller tubercles near posterior end; cardiac region with a few short, subconical tubercles; from posterior gastric region an irregular line of tubercles extends to the posterolateral angles of the carapace; external to the orbits there are three spines in a nearly transverse line, behind which the anterolateral margin is at first concave and then strongly convex ; the spines on the convex portion of the margin are large and subconical; behind the convex portion the margin is concave and devoid of spines; posterior margin arcuated and studded with conical tubercles. Rostrum rather short, with median spine, and cluster of spiny tubercles above the base. Tubercles of chelipeds and ambulatory legs spiniform; carpus of chelipeds with outer edge excavated, forming a smooth, deep, rounded sinus, which when approximated to the shallower corresponding sinus on the anterior edge of the carpus of the first pair of ambulatory legs forms a striking, smooth, nearly circular hole, or foramen, from which this species derives its name and by which it is distinguished from all others. Abdomen similar to that of *L. mandtii.*

Dimensions.—Type: length of carapace 132.1 mm., width 214.9 mm.

Type Locality.—Off the coast of California, near San Francisco.

Distribution.—Victoria, British Columbia, to off San Diego, California, to a depth of 299 fathoms.

Remarks.—Easily recognized by the remarkable foramen between the chelipeds and the first ambulatory legs (Holmes).

Genus **Rhinolithodes** Brandt

Carapace triangular, with a deep semilunar fossa separating the smooth hemispherical cardiac region from the other regions of the carapace, which are roughly and more or less coarsely tuberculate, and raised above the cardiac region. Plates of basal (second), and three following abdominal segments distinct.

Rhinolithodes wosnessenskii Brandt

Plate 22, figure 1

Rhinolithodes wossnesenskii Brandt, Bull. Phys.-Math. Acad. Imp. Sci. St. Petersb., **7**, 174, 1849 (typographical error for *wosnessenskii*).

Rhinolithodes wosenessenskii Newcombe, Bull. Nat. Hist. Soc. Brit. Col., p. 28, pl. 3, 1893; Way, Puget Sd. Mar. Sta. Publ., **1**, 354, fig. 11, 1917.

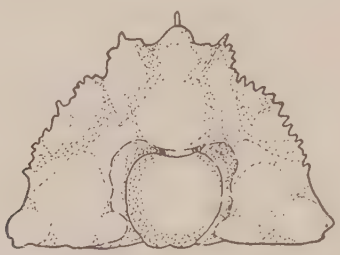


Fig. 103. *Rhinolithodes wosnessenskii*, dorsal view of carapace, × ⅝ (after Newcombe).

Characters.—Chelipeds and ambulatory legs armed with short, stout, pointed spines, bearing at their tips a few coarse hairs. Abdomen unornamented except for numerous small papilliform tubercles.

Dimensions.—Type: length of carapace 42.4 mm., width at posterior margin 48.7 mm.

Color.—Of carapace grayish tan, with orange markings in the depressions on the dorsal side, on the tubercles of posterior part of carapace, and on abdomen and branchial region. Legs not highly colored but grayish tan like the general color of carapace (Way).

Type Locality.—Sitka and Kadiak, Alaska.

Distribution.—Kadiak, Port Etches, and Sitka, Alaska; Crescent City, California.

Genus **Paralomis** White

Carapace coarsely granulate, tuberculate, or armed with numerous short, often blunt spines; gastric region usually with a strong, sharply pointed spine. Basal (second) segment entire; median plates of third to fifth segments distinct, often separated from one another by a membranous interval, covered by calcified nodules; lateral plates of these segments subequal in both sexes.

Key to the California Species of Paralomis

I. Carapace spiny, particularly marginal, gastric, and rostral regions. Ambulatory legs angular, not at all compressed, with spines arranged in rows on angles or ridges. (Known only from 625 + fathoms.)

multispina, p. 159.

II. Carapace tuberculated, margins spiny, a single acute spine on gastric region. Ambulatory legs much compressed, anterior and posterior margins set with sharp spines. (Known only from 688 + fathoms.)

verrilli, p. 159.

Paralomis multispina (Benedict)

Plate 23; plate 30, figures 7 and 8

Leptolithodes multispinus Benedict, Proc. U. S. Nat. Mus., **17**, 484, 1894.
Paralomis multispina Bouvier, Ann. Sci. Nat. (8), **1**, 25, 1896.
Leptolithodes multispina Rathbun, H. A. E., **10**, 165, 1904.

Original Description.—The carapace is about as broad as long; the areolations are well defined. On the median line at the summit of the gastric region there is a sharp spine about 4 mm. in length. The lateral margins are armed with from twelve to sixteen spines about 3 mm. in length. In the young and in some of the adults there are small spines on the branchial region. A semicircular line of six or seven spines marks the limits of the branchial and intestinal regions. The carapace is thickly studded with blunt spines, each terminating in a flattened face or surface cut obliquely to the surface of the carapace; this face is encircled by a fringe of short, stiff bristles. The rostrum consists of a simple median spine with two basal spines. Under the rostrum proper there is a very short, conical spine homologous with the subrostral spine of *Lithodes;* behind the spine are one or more spinules. The abdomen in the male is composed, after the second segment, of several rows of leathery plates; the second segment is better calcified and harder. The abdomen of the female is twisted to the right as in *Lithodes.*

The chelipeds are moderately slender and extend almost to the distal end of the carpal joints. The spines on the inner margin of the carpal segments are the most prominent. The ambulatory legs are long and slender and thickly set with spines. The spines of the merus are not so distinctly arranged in rows as on the carpal and propodal segments; there is, however, a distinct row on the upper margin. The spines of the carpus are arranged in eight more or less distinct rows; on the propodal segment the spines are arranged in six full rows and two half rows. There are four short rows of spines on the proximal end of the dactylus. The dactyli are compressed, slightly bent, and a little twisted (Benedict).

Dimensions.—Specimen of average size: length 80 mm., width 78 mm., distance from tip to tip of ambulatory legs 360 mm. (Benedict).

Type Locality.—Off Queen Charlotte Islands, British Columbia, 876 fathoms ("Albatross" station 2860).

Distribution.—From off Shumagin Bank, Alaska, to off San Diego, California, 625 to 876 fathoms (Rathbun).

Paralomis verrilli (Benedict)

Plate 24; plate 30, figures 5 and 6

Pristopus verrilli Benedict, Proc. U. S. Nat. Mus., **17**, 486, 1894.
Paralomis verrilli Bouvier, Ann. Sci. Nat. (8), **1**, 25, 1896.
Pristopus verrilli Rathbun, H. A. E., **10**, 165, 1904.

Original Description.—The carapace is verrucose, the areolations prominent. The gastric region is much elevated and is surmounted by a small spine. On each side, on the border of the branchial region, there is a deep pit. A groove runs from the pits to the depression between the gastric and cardiac regions. There are about twelve spines, two to three mm. in length on the lateral border of the carapace. The posterior boundary of the intestinal region is marked by a semicircular row of tubercles. The cardiac region is triangular; the apex of the triangle cuts well into the intestinal region where the depression that marks it runs into a deep slit or oblong median depression. The frontal margin is broad and straight. The spines of the anterior angles and the orbital spines point forward; the orbital spines are a little the longer. Between the spine on the angle and the orbit there is a row of smaller spines and one or two granules. The trispinose rostrum is composed of a bifurcate rostrum proper and the subrostral spine which extends much beyond the two upper rostral spines. The antennal

scale tapers to a sharp point and has three sharp spines or branches on each side. The lateral plates on the left of the abdomen in the female are fringed with short, slender, blunt spines.

The chelipeds extend a little beyond the middle of the propodal segment of the first pair of ambulatory feet. The right cheliped is stouter than the left. The prehensile edges of its fingers are strongly tubercular. The upper margin of the palm is spiny; there are also some small spines on the middle and on the lower margin. There are three long spines on the inner margin of the carpus. The left cheliped is similar but smaller, and the prehensile edges of the fingers are sharp. The ambulatory feet are wide and much compressed. The anterior and posterior margins are armed with sharp spines, alternating in general large and small. On the upper surface of the proximal end of the merus of the fourth pair of feet there is a row of fine spines; the corresponding spines on the third pair of feet are smaller, and on the second pair still smaller (Benedict).

Dimensions.—Type: length of carapace and rostrum 90 mm., rostrum 9 mm., width of carapace 82 mm.

Type Locality.—Off the Pribilof Islands, 688 fathoms.

Distribution.—Pribilof Islands, to off Cortez Bank, California, 688 to 822 fathoms (Rathbun).

Genus **Paralithodes** Brandt

Carapace armed with a number of strong, long spines. Third to fifth abdominal segments with median plates replaced by a membranous area covered by calcified, often spinous nodules; lateral plates of these segments in the female are very much larger on the left side than on the right; plates of basal (second) segment distinct, separated by evident sutures.

Key to the California Species of Paralithodes

I. Rostrum bifurcate, tip with two well developed divergent horns; anterior lateral spines of rostrum reaching to apex of bifurcation of rostrum. (Known only from 211 + fathoms.)

rathbuni, p. 160.

II. Rostrum simply bifid or split, two terminal spines thus formed approximated; anterior lateral spines of rostrum not reaching half way to bases of terminal spines. (Known only from 155 + fathoms.)

californiensis, p. 161.

Paralithodes rathbuni (Benedict)

Plate 26; plate 27; plate 29, figures 6 and 7; plate 30, figures 3 and 4

Lithodes rathbuni Benedict, Proc. U. S. Nat. Mus., **17**, 482, 1894.

Paralithodes rathbuni Bouvier, Ann. Sci. Nat. (8), **1**, 23, 1896.

Lithodes rathbuni Holmes, Occas. Papers Calif. Acad. Sci., **7**, 131, 1900.

Original Description.—Carapace of male armed with long spines on the different regions; also with longer spines on the margins. There are four on the gastric; two short and two long on the cardiac region. The branchial region has six spines of various lengths. The posterolateral margin has the longest spine, being 26 mm. in length on one side and 23 mm. on the other. Both have lost their points. Anterior to this there are three spines, the shortest unbroken one being 17 mm. long; on the margin posterior to the longest spine there are four spines, the longest of which is 14 mm. in length and the shortest 8 mm. The rostrum is composed of five branches; the main stem is sharply bent upward and

is strongly bifurcate; the lower horn is almost on the horizontal line of the body, and projects forward more like the usual main portion of the rostrum; the lateral branches arise at the base and project forward. The movable spine of the antenna is very long and slender; there is a short branch or spine on its outer and upper margin near the base.

The right cheliped is slender and rather weak. Its longest spine is situated on the distal upper margin of the merus. There are upwards of twelve spines on the carpus. On the median outer surface of the palm there are two rows of four spines each. The fingers gape at the base; their prehensile edges are tubercular. The left cheliped is smaller and more slender than the right. The cutting edges of the fingers run back to the gape, or a little more than one-half their length. The ambulatory legs are slender and very spiny; the spines are from 3 to 5 mm. in length (Benedict).

Dimensions.—Type, male: length of carapace exclusive of broken rostrum 65 mm., width 68 mm.

Type Locality.—Off San Simeon Bay, California, 211 fathoms (''Albatross'' station 3191; 1 male).

Distribution.—Also taken by the ''Albatross'' off San Diego, California, 201 to 220 fathoms (two female specimens, one each from stations 4359 and 4367).

Paralithodes californiensis (Benedict)

Plate 25; plate 30, figures 1 and 2

Lithodes californiensis Benedict, Proc. U. S. Nat. Mus., **17**, 483, 1894.

Paralithodes californiensis Bouvier, Ann. Sci. Nat. (8), **1**, 23, 1896.

Lithodes californiensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 131, 1900.

Original Description.—This species is remarkably like the preceding, except in the relative length of its spines and the form of the rostrum. The spines of the carapace are much shorter and stouter, but occupy the same relative position. On the lateral margin there are two long spines; the one above the third ambulatory foot equals in length, but is much stouter than the one similarly placed on the preceding species. The most marked difference between the two species is in the rostrum; in both specimens of *L.* [*P.*] *californiensis* the rostrum is bifid, while in *L.* [*P.*] *rathbuni* it is bifurcate, the tip being composed of two well developed divergent horns. The subrostral spine extends almost as far as the rostrum proper. The chelipeds are as in *L.* [*P.*] *rathbuni*, except that the spines are shorter and that there is less gape in the right hand and more in the left (Benedict).

Dimensions.—Type, female: length of carapace and rostrum 95 mm., width of carapace 82 mm.

Type Locality.—Off Santa Cruz Island, California, 155 fathoms (''Albatross'' station 2949; two females).

Distribution.—Also taken by the ''Albatross'' off San Diego, California, 141 to 167 fathoms (station 4358; 1 female).

Genus **Lithodes** Latreille

Like *Paralithodes* except that plates of basal (second) abdominal segment are more or less fused, either completely or with median and lateral, or lateral and marginal plates fused together.

Lithodes couesi Benedict

Plate 28; plate 29, figures 3, 4, and 5

Lithodes couesi Benedict, Proc. U. S. Nat. Mus., **17**, 481, 1894.

Original Description.—This species reminds one of *L. maia* [L.]. The largest spines of the carapace are arranged about the margin; they are slender and sharp. The longest are situated at the outer orbital angles, the antennal angles, the hepatic regions, and three on the margin of the branchial regions. The spines on the intervening spaces of the margin are more numerous and much smaller. The surface of the carapace is set with short, sharp, conical spines. The gastric region is swollen and well defined. The cardiac region is barely indicated between the confluent branchial regions. The depression between the gastric and cardiac regions is very deep. The rostrum is 20 mm. long, and made up as in *L. maia*, but the terminal portion beyond the distal lateral branches is slender and bifid rather than bifurcate, as in *L. maia;* the basal branches are a little farther forward. The scale is rudimentary; the spine at the outer angle is branched at the base, the branch consisting of a single short, sharp spine on the outer surface. The abdomen is without spines; the spines of *L. maia* are replaced by tubercles; those of the first segment are very much closer together than the corresponding spines in *L. maia*. The tubercles on the lower margin of the second segment are low, and somewhat oblong at base; those in the center of segment are larger.

The chelipeds are slender and weak. The armature of the fingers of the right hand is slight; the fingers gape. The fingers of the left hand are long and slender and gape at base. The spines of the chelipeds and ambulatory legs are numerous and arranged about as in *L. maia*, but are shorter (Benedict).

Dimensions.—Type, male: length of carapace and rostrum 105 mm.; width of carapace 81 mm.

Type Locality.—North of Unalaska; 399 fathoms ("Albatross" station 3329, 1 male).

Distribution.—Bering Sea to off San Diego; 301 to 530 fathoms.

Remarks.—From the Shumagin Banks, Alaska ("Albatross" station 3338), Benedict records three young specimens which he refers to this species "without hesitation." Regarding them he says: "The rostrum differs in being bifurcate as in *L. maia*. It is possible that additional specimens of the adult might show the rostrum to be bifurcate rather than bifid." This does not prove to be the case, however, for two adult males from off San Diego ("Albatross" stations 4400 and 4333) have the characteristic rostrum of the type. Two other young specimens were also taken off San Diego in 500 to 530 fathoms ("Albatross" station 4335).

Family Galatheidae

Body shrimp-like. Abdomen bent upon itself but not folded up against the thorax; tail-fan well developed, adapted for swimming. First legs chelate, greatly elongated, slender. Antennal peduncle four-jointed owing to fusion of true second and third joints; flagellum long.

Key to the California Genera of the Galatheidae

I. Latero-inferior regions of carapace greatly swollen so that epimeral structures, sides of carapace, are visible in dorsal view. Rostrum long and slender, with a supraorbital tooth on either side of the base. Abdomen dorsally unarmed. (From ninety miles southwest of San Francisco southward.)

Pleuroncodes, p. 163.

II. Latero-inferior regions of carapace not bulging, not visible from above.

A. Eyes faceted and well pigmented. Integument crisp. Exopodite of first maxilliped terminating in a flagellum.

1. Rostrum broad, flattened dorsoventrally, laterally toothed. Abdomen dorsally unarmed. (Known from off Santa Cruz Island.)

Galathea, p. 163.

2. Rostrum long and slender, spine-like, laterally compressed, unarmed; with a well developed supraorbital spine on either side of the base. Abdomen often unarmed dorsally.

Munida, p. 164.

B. Eyes opaque, non-faceted, and devoid of pigment. Integument thick, and very strongly calcified. Exopodite of first maxilliped not terminating in a flagellum. Rostrum elongate triangular, with or without lateral spines. Abdomen generally armed dorsally.

Munidopsis, p. 167.

Genus **Pleuroncodes** Stimpson

Carapace with latero-inferior regions swollen so that epimeral structures, sides of carapace, are visible from above. Rostrum long and slender, spiniform, with a supraorbital tooth on either side of the base. Abdomen dorsally unarmed.

Pleuroncodes planipes Stimpson

Plate 31, figure 2

Pleuroncodes planipes Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 245, 1860.—Holmes, Occas. Papers Calif. Acad. Sci., 7, 112, 1900.

Characters.—Carapace more or less convex, tapering anteriorly, transversely rugose, anterior edges of rugae fringed with closely set short hairs; with the exception of a few spinules behind the supraorbital teeth carapace is devoid of spines above; there is a spine at the rounded anterolateral angle, behind which there are a few spines on the lateral margin. Rostrum long and slender, scabrous above, and continued upon the carapace as a carina; supraorbital teeth spine-like, confluent at base with rostrum. Chelipeds slightly hairy; ambulatory legs scabrous, with penultimate joints distinctly flattened and ciliated.

Dimensions.—Type, male: length of carapace, rostrum included, 24.1 mm., greatest width 13.7 mm.

Type Localities.—Pacific Ocean, lat. 24° N, long. 130° W, and Monterey, California.

Distribution.—From ninety miles southwest of San Francisco, California, to 150 miles southwest of Cape St. Lucas, Lower California.

Remarks.—This species lives in the open ocean and is sometimes found in vast quantities in the Pacific Ocean off the American coast. In March, 1859, it was thrown ashore in considerable numbers at Monterey, California (Stimpson).

Genus **Galathea** Fabricius

Rostrum flattened dorsoventrally, rather broad, laterally toothed. Ocular peduncles distally dilated only slightly if at all. Abdominal segments unarmed. Carapace more or less evenly convex, tapering somewhat anteriorly, transversely rugose, anterior edges of rugae fringed with closely set, short hairs, dorsal surface with one or more pairs of sharp spines, lateral margins spiny.

Lithodes couesi Benedict

Plate 28; plate 29, figures 3, 4, and 5

Lithodes couesi Benedict, Proc. U. S. Nat. Mus., 17, 481, 1894.

Original Description.—This species reminds one of *L. maia* [L.]. The largest spines of the carapace are arranged about the margin; they are slender and sharp. The longest are situated at the outer orbital angles, the antennal angles, the hepatic regions, and three on the margin of the branchial regions. The spines on the intervening spaces of the margin are more numerous and much smaller. The surface of the carapace is set with short, sharp, conical spines. The gastric region is swollen and well defined. The cardiac region is barely indicated between the confluent branchial regions. The depression between the gastric and cardiac regions is very deep. The rostrum is 20 mm. long, and made up as in *L. maia*, but the terminal portion beyond the distal lateral branches is slender and bifid rather than bifurcate, as in *L. maia;* the basal branches are a little farther forward. The scale is rudimentary; the spine at the outer angle is branched at the base, the branch consisting of a single short, sharp spine on the outer surface. The abdomen is without spines; the spines of *L. maia* are replaced by tubercles; those of the first segment are very much closer together than the corresponding spines in *L. maia.* The tubercles on the lower margin of the second segment are low, and somewhat oblong at base; those in the center of segment are larger.

The chelipeds are slender and weak. The armature of the fingers of the right hand is slight; the fingers gape. The fingers of the left hand are long and slender and gape at base. The spines of the chelipeds and ambulatory legs are numerous and arranged about as in *L. maia,* but are shorter (Benedict).

Dimensions.—Type, male: length of carapace and rostrum 105 mm.; width of carapace 81 mm.

Type Locality.—North of Unalaska; 399 fathoms ("Albatross" station 3329, 1 male).

Distribution.—Bering Sea to off San Diego; 301 to 530 fathoms.

Remarks.—From the Shumagin Banks, Alaska ("Albatross" station 3338), Benedict records three young specimens which he refers to this species "without hesitation." Regarding them he says: "The rostrum differs in being bifurcate as in *L. maia.* It is possible that additional specimens of the adult might show the rostrum to be bifurcate rather than bifid." This does not prove to be the case, however, for two adult males from off San Diego ("Albatross" stations 4400 and 4333) have the characteristic rostrum of the type. Two other young specimens were also taken off San Diego in 500 to 530 fathoms ("Albatross" station 4335).

Family Galatheidae

Body shrimp-like. Abdomen bent upon itself but not folded up against the thorax; tail-fan well developed, adapted for swimming. First legs chelate, greatly elongated, slender. Antennal peduncle four-jointed owing to fusion of true second and third joints; flagellum long.

Key to the California Genera of the Galatheidae

I. Latero-inferior regions of carapace greatly swollen so that epimeral structures, sides of carapace, are visible in dorsal view. Rostrum long and slender, with a supraorbital tooth on either side of the base. Abdomen dorsally unarmed. (From ninety miles southwest of San Francisco southward.)

Pleuroncodes, p. 163.

II. Latero-inferior regions of carapace not bulging, not visible from above.
A. Eyes faceted and well pigmented. Integument crisp. Exopodite of first maxilliped terminating in a flagellum.
1. Rostrum broad, flattened dorsoventrally, laterally toothed. Abdomen dorsally unarmed. (Known from off Santa Cruz Island.)
Galathea, p. 163.
2. Rostrum long and slender, spine-like, laterally compressed, unarmed; with a well developed supraorbital spine on either side of the base. Abdomen often unarmed dorsally.
Munida, p. 164.
B. Eyes opaque, non-faceted, and devoid of pigment. Integument thick, and very strongly calcified. Exopodite of first maxilliped not terminating in a flagellum. Rostrum elongate triangular, with or without lateral spines. Abdomen generally armed dorsally.
Munidopsis, p. 167.

Genus **Pleuroncodes** Stimpson

Carapace with latero-inferior regions swollen so that epimeral structures, sides of carapace, are visible from above. Rostrum long and slender, spiniform, with a supraorbital tooth on either side of the base. Abdomen dorsally unarmed.

Pleuroncodes planipes Stimpson

Plate 31, figure 2

Pleuroncodes planipes Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 245, 1860.—Holmes, Occas. Papers Calif. Acad. Sci., 7, 112, 1900.

Characters.—Carapace more or less convex, tapering anteriorly, transversely rugose, anterior edges of rugae fringed with closely set short hairs; with the exception of a few spinules behind the supraorbital teeth carapace is devoid of spines above; there is a spine at the rounded anterolateral angle, behind which there are a few spines on the lateral margin. Rostrum long and slender, scabrous above, and continued upon the carapace as a carina; supraorbital teeth spine-like, confluent at base with rostrum. Chelipeds slightly hairy; ambulatory legs scabrous, with penultimate joints distinctly flattened and ciliated.

Dimensions.—Type, male: length of carapace, rostrum included, 24.1 mm., greatest width 13.7 mm.

Type Localities.—Pacific Ocean, lat. 24° N, long. 130° W, and Monterey, California.

Distribution.—From ninety miles southwest of San Francisco, California, to 150 miles southwest of Cape St. Lucas, Lower California.

Remarks.—This species lives in the open ocean and is sometimes found in vast quantities in the Pacific Ocean off the American coast. In March, 1859, it was thrown ashore in considerable numbers at Monterey, California (Stimpson).

Genus **Galathea** Fabricius

Rostrum flattened dorsoventrally, rather broad, laterally toothed. Ocular peduncles distally dilated only slightly if at all. Abdominal segments unarmed. Carapace more or less evenly convex, tapering somewhat anteriorly, transversely rugose, anterior edges of rugae fringed with closely set, short hairs, dorsal surface with one or more pairs of sharp spines, lateral margins spiny.

Characters.—Abdomen unarmed. Rostrum long, slender, spine-like, laterally compressed, unarmed, moderately serrate above and slightly so below. The straight, slender supraocular spines do not reach quite to the ends of the eyes and are united to the rostrum for nearly one-half their length. The marginal spines of the carapace vary from eight to ten on a side; there are six spines on the gastric area, four in a line in the usual place behind the supraocular spines, and one on each side near the hepatic region; the terminal spines of the line are very weak and small; but one spine occupies the anterior branchial region; posterior margin unarmed. Chelipeds well set with spines and spinules, not hairy.

Dimensions.—Type, length 35 mm.

Type Locality.—Off Cape Beale, Vancouver Island, British Columbia, 66 fathoms ("Albatross" station 2878).

Distribution.—From Sitka, Alaska, to Los Coronados Islands, Lower California, 50 to 638 fathoms.

Remarks.—Probably the species designated by Owen as *M. gregaria* (Rathbun).

Munida hispida Benedict

Plate 31, figure 3

Munida hispida Benedict, Proc. U. S. Nat. Mus., **26**, 260, fig. 10, 1902.

Characters.—Second, third, and fourth segments of abdomen armed; second and third with two rows of spines, fourth with one; second of the double rows wanting in all but the largest specimens. Rostrum more than twice as long as supraocular spines, slightly sigmoid and minutely serrate. Supraocular spines little longer than the eyes, stout at base, and tapering rapidly to a sharp point. Marginal spines of carapace, not counting those at anterolateral angles, from seven to ten on a side; gastric spines small, with a much smaller pair placed anteriorly and closer together; on median line of gastric region there are five or six spines, and on a ridge behind these is a row of spinules; a number of spinules are scattered over the anterior portion and the sides of this area; there are about sixteen spinules on the triangular area, a spine on the branchial area just behind the apex of the triangle, and another paired spine behind this; posterior border of carapace armed with from ten to about eighteen low spines. Chelipeds stout, prismatic, and spinose; not hairy.

Dimensions.—Type, male: length from extremities of the rostrum and telson 83 mm., length of right cheliped 186 mm., merus 70 mm., palm 53 mm., fingers 30 mm. Specimen from off Santa Catalina Island (plate 31, figure 3): length of carapace and rostrum 20 mm., of right cheliped 36 mm.

Type Locality.—Off Galapagos Islands, 271 fathoms ("Albatross" station 2817).

Distribution.—Also taken off Santa Catalina Island, 178 to 195 fathoms ("Albatross" station 4410); off La Jolla, California, 158 fathoms (Scripps Institution, haul 1157); and northwest of Cerros Island, Lower California, 171 fathoms ("Albatross" station 2987).

Remarks.—The variation between the large specimen taken for the type and the smaller specimens is considerable. The carapace of the smaller ones lack many of the spinules, and the spines are larger; the fourth segment of the abdomen may show only two small protuberances in place of the row of spines. The chelipeds are much shorter, and they are armed with definite rows of spines; the palm is prismatic, and the prehensile edges of the fingers are in contact throughout. The rostrum in some of the smallest is slightly bent upward. With all this variation, however, the specimens intergrade, and in my opinion give no ground for separation (Benedict).

Fig. 106. *Munida hispida,* type, × ⅜ (from Benedict, U. S. N. M.).

Genus **Munidopsis** Whiteaves

Rostrum well developed; sometimes with a small supra-antennal tooth or spine on either side but never with a long supraorbital spine. Eyes opaque, non-faceted, and devoid of pigment. Integument very strongly calcified. Carapace generally

quite flat, more or less quadrilateral in outline, dorsal surface usually rugose, sometimes spinose, but occasionally glabrous, and either prominently or obscurely tuberculated.

Key to the California Species of Munidopsis

I. Abdomen unarmed. Eye-stalks spined above. Rostrum acuminate, laterally unarmed. Chelipeds hairy. (Known only from 684+ fathoms.)
verrilli, p. 169.

II. Abdomen armed with spines or tubercles.
A. Rostrum laterally spined. Eye-stalks spined above. Dorsal armature of abdomen not confined to median line. Chelipeds hairy. (Known only from 302 + fathoms.)
hystrix, p. 168.

B. Rostrum not armed with lateral spines, acuminate. Eye-stalks not spined. Dorsal armature of abdomen confined to median line.
1. Anterior margin of carapace with a small, serrated lobe on either side of base of rostrum behind ocular peduncle; lateral margins arcuate. Chelipeds hairy. (Not known north of Santa Catalina Island.)
aspera, p. 171.

2. Anterior margin of carapace straight, at right angles to lateral margins; lateral margins straight. Chelipeds not hairy.
quadrata, p. 170.

Munidopsis hystrix Faxon

Munidopsis hystrix Faxon, Bull. Mus. Comp. Zool., **24**, 183, 1893; Mem. Mus. Comp. Zool., **18**, 89, pl. 19, figs. 1, 1*a*, 1895; Rathbun, H. A. E., **10**, 166, 1904.

Fig. 107. *Munidopsis hystrix*, × about ¾ (after Faxon).

Characters.—Rostrum long, lightly curved upward from the base to the tip, and armed with from two to five spines on each side; spines unsymmetrically arranged on the two sides. Eye-stalks armed with a single spine above. Carapace setose and thickly covered with small spinous tubercles; three spines of special prominence on the gastric area disposed in the form of a triangle, with apex

directed backward; one on the cardiac area; two (rarely six) on the hind margin of the carapace; one on each branchial area; there is a spine at the external angle of the orbit, and the lateral margin of the carapace is spinose. Second, third and fourth segments of abdomen conspicuously two-ridged; the second segment has a pair of small spines on the anterior ridge, and another pair nearer the median line on the posterior ridge; third segment also with a pair of spines on the anterior ridge, and occasionally with a third spine in the median line on the posterior ridge. Chelipeds long, hairy, and very spiny from the proximal end of the merus to the base of the fingers.

Dimensions.—Type, ovigerous female: length 48.5 mm.; length of carapace 26 mm.; breadth 15 mm.; length of rostrum 8 mm.

Type Localities.—Off Tres Marias Islands ("Albatross" stations 3424 and 3425), 676 to 680 fathoms, and off Acapulco, Mexico ("Albatross" station 3417), 493 fathoms.

Distribution.—From off Anacapa Island, California, to off Acapulco, Mexico; 302 to 680 fathoms.

Munidopsis verrilli Benedict

Munidopsis verrilli Benedict, Proc. U. S. Nat. Mus., 26, 291, fig. 34, 1902.

Fig. 108. *Munidopsis verrilli,* × 1⅔ (from Benedict, U. S. N. M.).

Characters.—Abdomen unarmed. Rostrum slender and triangular in cross section, upper margin running back as a carina to a point behind the spines of the gastric region. Front, from base of rostrum to a point under the anterolateral spine, is nearly straight and is at an angle of about forty-five degrees to the median line. Eye-stalks armed with two spines, of which the inner is much the longer.

Carapace is iridescent; the short and rather elevated rugae are hairy. Merus and carpus of ambulatory legs spiny. Merus of chelipeds triangular in cross-section, with four spines on the upper ridge and two on the inner; carpus with five or six spines; two prominent ones on the crest of the palm; prehensile edges of fingers evenly dentate.

Dimensions.—Type: length of carapace and rostrum 22 mm., of rostrum about 5 mm.; length of hand 13 mm.

Type Locality.—Off San Diego, California, 822 fathoms ("Albatross" station 2923).

Distribution.—From Monterey Bay, California, to off Cerros Island, Lower California, 684 to 1084 fathoms.

Munidopsis quadrata Faxon

Munidopsis quadrata Faxon, Bull. Mus. Comp. Zool., **24**, 188, 1893; Mem. Mus. Comp. Zool., **18**, 97, pl. 23, fig. 1, 1895; Rathbun, H. A. E., **10**, 167, 1904.

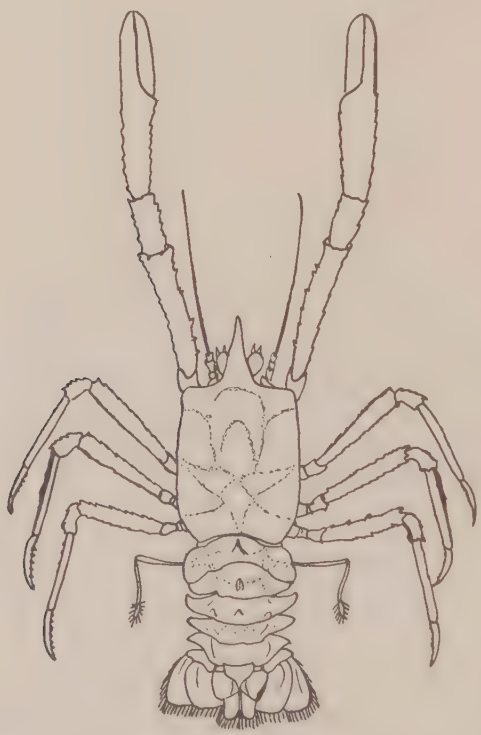


Fig. 109. *Munidopsis quadrata*, × about 2 (after Faxon).

Characters.—Lateral margins of carapace straight, at right angles to straight anterior margin, upper surface spineless but furnished with scattered low, squamous tubercles; central part of the gastric region prominent above the anterior branchial lobes, from which it is separated by deep pits; a prominent transverse ridge on the cardiac region forms the posterior wall of a deep fossa. Second segment of abdomen armed with a median spine, which is curved forward, third

and fourth segments with a very prominent ridge, which bears an acute median tooth. Length of rostrum variable, but always exceeding eye-stalks, usually by twice their length. Chelipeds not hairy.

Dimensions.—Type: length of body 29 mm., length of carapace 15.5 mm., width of carapace 9 mm.

Type Locality.—Off Tres Marias Islands, 676 fathoms ("Albatross" station 3424).

Distribution.—From off Destruction Island, Washington, to Tres Marias Islands, Mexico; 134 to 859 fathoms; also at 47 and 60 fathoms, off Wilmington, California, and Los Coronados Islands, respectively. Usually between 350 and 700 fathoms (Rathbun).

Munidopsis aspera (Henderson)

Plate 31, figure 1

Elasmonotus asper Henderson, Ann. Mag. Nat. Hist. (5), **16**, 416, 1885; "Challenger" Rept., Zool., **27**, Anomura, p. 163, pl. 19, fig. 4, 1888.

Munidopsis aspera Rathbun, H. A. E., **10**, 167, 1904.

Characters.—Lateral margins of carapace arcuate, anterior margin with small serrated lobe on orbital border behind ocular peduncle, upper surface beset with irregular subacute tubercles, some of which are more prominent and even compound toward median line of gastric area, tubercles more numerous elsewhere toward lateral and posterior margins and two of large size are situated on the cardiac area overhanging a shallow transverse groove; intervening spaces finely granular. Second and third abdominal segments are each provided with a prominent median tubercular elevation, the surface of which is roughened; scattered tubercles of small size present toward lateral margins of same segments, posterior segments smooth. Length of rostrum variable, usually twice length of eye-stalks, though in some male specimens it scarcely exceeds their length. Chelipeds hairy.

Dimensions.—Type, ovigerous female: length of body 28 mm., length of chelipeds 27 mm.

Type Localities.—Off Patagonia, 425 fathoms, and off coast of Brazil, 1500 fathoms.

Distribution.—Also taken by the "Albatross" from off Santa Catalina and San Clemente islands, California, to Straits of Magellan and Galapagos islands, 57 to 782 fathoms. Mostly between 400 and 600 fathoms. Brazil, 1500 fathoms (Henderson).

Family Albuneidae

First pair of legs subchelate; second to fourth legs with last joint curved and flattened. Carapace flattened, without wings to cover the legs. Third maxillipeds narrow, with exopodites. Abdomen bent under thorax; tail-fan not adapted for swimming.

Key to the California Genera of Albuneidae

I. Eye-peduncles very slender, elongated, cylindrical, and articulated in the middle. (Not known north of San Francisco.) *Blepharipoda*, p. 172.

II. Eye-peduncles lamellate, compressed, almost squamiform, cornea rudimentary. (Not known north of San Pedro.) *Lepidopa*, p. 172.

Genus **Blepharipoda** Randall

Eye-peduncles very slender, elongated, cylindrical, and articulated in the middle. Antennae with an acicle. Third maxillipeds with third or merus joint narrow and similar to the fourth, or carpus, which is not produced at its antero-external angle.

Blepharipoda occidentalis Randall

Plate 31, figure 6

Blepharipoda occidentalis Randall, Jour. Acad. Nat. Sci. Phila., **8**, 131, pl. 6, 1839; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 104, 1900; Rathbun, H. A. E., **10**, 167, 1904; Baker, Rept. Laguna Mar. Lab., **1**, 102, 1912.

Characters.—Carapace oblong, scabrous in front, smooth and punctate behind, tapering posteriorly, somewhat obliquely elevated toward the center, which is faintly carinate; median projection of front spiniform; anterolateral margin with three large spines and a smaller fourth one some distance back; longitudinal median ridge with a spine at anterior end only. Antennules not exceeding the length of the carapace. Telson suborbicular, thick and convex in the middle, but with sides laminate.

Dimensions.—Type, length about 50.8 mm.

Type Locality.—San Diego, California.

Distribution.—From San Francisco, California (D. S. Jordan), to San Quentin Bay and Rosalia Bay, Lower California (Rathbun).

Remarks.—This large species is one of the most remarkable crustaceans on the coast, found occasionally on sandy shores below low tide. Boys locate them with their feet while in bathing and dive for them (Baker).

Genus **Lepidopa** Stimpson

Eye-peduncles lamellate, compressed, almost squamiform, cornea rudimentary. Antennae with a very small acicle. Third maxillipeds with the fourth joint produced at its antero-external angle into a lobe, which reaches to or beyond the distal extremity of the fifth (penultimate) joint.

Lepidopa myops Stimpson

Plate 31, figure 4

Lepidops myops Stimpson, Ann. Lyc. Nat. Hist. N. Y., **7**, 241, 1860 (1862); Miers, Jour. Linn. Soc. London (Zool.), **14**, 333, pl. 14, fig. 16, 1879.

Lepidopa myops Holmes, Occas. Papers Calif. Acad. Sci., **7**, 105, 1900; Benedict, Proc. U. S. Nat. Mus., **26**, 892, fig. 4, 1903.

Characters.—Carapace somewhat square, about as long as wide, marked with transverse grooves; median projection of front rounded; anterolateral margin with a single spine; longitudinal median ridge unarmed. Antennules more than twice as long as carapace. Telson of male triangular, broad, rounded on the sides at its proximal and acute at its distal extremity; telson of female ovate, triangular, more rounded and obtuse at its distal extremity.

Dimensions.—Type, female: length of carapace 10.4 mm., width 11.9 mm.

Type Locality.—Cape St. Lucas, Lower California.

Distribution.—From San Pedro, California, to Cape St. Lucas, Lower California.

Family Hippidae

First pair of legs simple; second to fourth legs with last joint curved and flattened. Carapace subcylindrical, with wings which cover the legs. Third maxillipeds broad, without exopodites. Abdomen bent under thorax; tail-fan not adapted for swimming.

Genus **Emerita** Gronovius, Benedict

Antennae with flagellum very long, robust, multiarticulate, and strongly ciliated, normally hidden, coiled beneath the external mouth parts. Third pair of maxillipeds with ischium very small, and merus very large; terminal joint narrow and compressed. Dactyls of first pair of legs oval and lamellate.

Emerita analoga (Stimpson)

Plate 31, figure 5

Hippa analoga Stimpson, Proc. Boston Soc. Nat. Hist., **6**, 85, 1857; Miers, Jour. Linn. Soc. London (Zool.), **14**, 324, pl. 5, fig. 10, 1879; Ortmann, Zool. Jahrb., Abt. f. Syst., **6**, 537, pl. 26, fig. 1, 1892; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 103, 1900.

Emerita analoga Rathbun, H. A. E., **10**, 168, 1904; Weymouth and Richardson, Smithson. Misc. Coll., **59**, no. 7, 1912; Mead, Univ. Calif. Publ. Zool., **16**, 431, 1917.

Fig. 110. *Emerita analoga,* dorsal view, natural size.

Characters.—Carapace oblong-oval, very convex, and marked with irregular transverse, crenulated lines, which become much less marked toward the sides and the posterior end; median projection of front subtriangular but rounded at the tip; lateral lobes triangular and acute, projecting further forward than median lobe, from which they are separated by round, smooth sinuses. Eye-stalks long and very slender. Merus of maxillipeds with lobe at antero-internal angle rounded. Telson narrowly triangular, acute; outer surface convex, smooth, and glossy.

Dimensions.—Length of carapace 29 mm., width 23 mm., length of telson 19 mm., width of telson 9.5 mm., length of abdomen when extended 37 mm. The ratio of the length of the carapace to its width is quite variable (Holmes). The length of the carapace of the Biological Survey specimens ranged from 10 to 25 mm., averaging about 17 mm.

Color.—A bluish or cinereous color above and yellowish white below; the fringing hairs are mostly black (Stimpson).

Type Locality.—California.

Distribution.—According to Holmes this species extends from Oregon to Panama. The collections in the U. S. National Museum range from Drake's Bay, California, to San Bartolomé Bay, Lower California, and from Peru to Chile. The intermediate region (from Lower California to Panama) is represented by *E. emerita* (Fabricius), which occurs also on the Atlantic side of tropical America (Rathbun).

Remarks.—The sand crab inhabits a strip of beach in or near the wash of the waves. Here it is distributed from the high-tide limit, for a given tide, to a short distance beyond the point where the waves strike the sand, but the center of abundance is that portion washed by each wave....

Although occasionally found singly, *Emerita* is essentially a gregarious animal. It occurs in large "beds," which are marked by small V-shaped ripples in the sand. Here, as Leidy has said of the eastern form, they are as thick as currants in plum pudding. If one turns over the sand of one of these beds he will find the sand crab in incredible numbers lying within a few inches of the surface. In these places adults and young of both sexes may be found associated. Generally mature females and males are at once distinguished by the difference in size.... For this reason collections often consist of females only, the smaller males being regarded as young. Measurements of the carapace of 27 specimens (length from rostrum to median posterior dorsal margin) of each sex collected at Pacific Grove give the following: average of males (all with enlarged genital papillae) 12.4 mm., range 10.5 to 14.5 mm.; average of females (all egg-bearing) 21.4 mm., range 17 to 25.5 mm. The males are without pleopods, while the second, third and fourth segments of the abdomen of the females are provided with them. The telson of the adult female is more heavily ciliated along its lateral margin and is somewhat wider than that of the male. The following are measurements of two typical specimens: female, length of carapace 20.3 mm., length of telson 13 mm., width of telson 6.9 mm., width 53% of length; male, length of carapace 11 mm., length of telson 7.6 mm., width of telson 3.3 mm., width 43% of length. (Weymouth and Richardson.)

Biological Survey of San Francisco Bay.—There are only three specimens of *Emerita analoga* in the bay collection: one, which was apparently alone, was dug up in the sand on the beach skirting the Presidio shore west of Fort Point; another was obtained while seining on the Fort Baker beach, and the third was taken, also in the seine, on the beach west of Blunt Point, on the southern shore of Angel Island. Owing to lack of more intensive sandy beach collecting no definite statements can be made regarding the distribution and occurrence of this species in the region covered by the survey.

Family Porcellanidae

Body crab-like. Abdomen bent under and folded against the thorax; tail-fan well developed. First pair of legs chelate, moderately elongate, stout; fifth pair small and elevated so that they rest on the carapace.

KEY TO CALIFORNIA GENERA OF THE PORCELLANIDAE

I. Epimera (pleural, subbranchial, or lateral portions of the carapace) entire. Chelipeds equal or subequal, broad and flattened; carpus more or less elongated.

Petrolisthes, p. 178.

II. Epimera posteriorly broken up, the posterior portion of the subbranchial region subquadrate and separated from the larger anterior portion by a membranous or cutaneous interspace. Chelipeds unequal, thick, and more or less roughened; carpus short.

Pachycheles, p. 175.

Genus **Pachycheles** Stimpson

Carapace rounded, ovate, at least as broad as long, with lateral margins marked by an elevated line; front somewhat deflexed, a little prominent at the middle, and subacute, but never dentated, with its apex concealed by pubescence; epimera posteriorly broken up, the posterior portion of the subbranchial region subquadrate and separated from the larger anterior portion by a membranous or cutaneous interspace. First or basal joint of antennal peduncle produced and joined to the margin of the carapace; second joint at some distance from the orbit. Chelipeds unequal, thick, and more or less roughened, carpus short.

The species of this genus, listed below, in general appearance are all very much alike; the carapace is round-ovate; front short, depressed, and pubescent; chelipeds unequal, either the right or left the larger; carpus with two to three rows of the granules more prominent than the rest; ambulatory legs more or less pubescent on upper margin; propodi and dactyli spinulous below.

KEY TO THE CALIFORNIA SPECIES OF PACHYCHELES

I. Chelipeds rugose, granulated, and tuberculated above, and furnished with a prominent, naked, granulated tubercle on the median distal portion of the palm, near the gape of the fingers. Lateral (not terminal) plates of telson in one piece.

A. Chelipeds covered with a thick, dense, even, velvety pubescence, which also fills the gape between the fingers of the larger hand. (Santa Monica Bay to San Diego.)

holosericus, p. 177.

B. Chelipeds with only a few scattered, coarse hairs on upper surface, and with only a few if any in the gape of the fingers.

rudis, p. 176.

II. Chelipeds evenly rounded and not tuberculated above, quite uniformly granulated; granules hidden beneath a short, thick pubescence, interspersed with numerous tufts of longer hairs; gape between the fingers of the larger hand filled with a dense, bushy pubescence. Lateral plates of telson composed of two pieces, a small rounded proximal portion, and a large distal portion which alone constitutes the lateral plate of the other species of *Pachycheles* here listed. (Not found south of San Francisco Bay.)

pubescens, p. 177.

Pachycheles rudis Stimpson

Plate 33, figure 2

Pachycheles rudis Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 76, pl. 1, fig. 5, 1859 (1860); Lockington, Ann. Mag. Nat. Hist. (5), 2, 394, 1878; Holmes, Occas. Papers Calif. Acad. Sci., 7, 109, 1900; Rathbun, H. A. E., 10, 168, pl. 6, fig. 6, 1904; Baker, Rep. Laguna Mar. Lab., 1, 102, 1912.

a *b*

Fig. 111. *Pachycheles rudis*, ♀; *a*, dorsal view, natural size (from Stimpson); *b*, telson, × 2.

Characters.—Chelipeds unequal, with a rugose, irregularly tuberculated and granulated upper surface, provided with a few scattered coarse hairs, of which only a few, if any, are to be found in the gape of the fingers of the larger hand. In the sulci between the granules there is a faint pubescence, which is scarcely evident to the naked eye and which never in the least obscures any of the granulations.

The large, prominent, granulated tubercle on the median distal portion of the palm is low and rounded, about as high as wide at the base, or less; occasionally several longitudinal lines of larger granules are evident behind the large tubercle but they are always more or less inconspicuous and never attain the prominence of those similarly placed in *P. holosericus*.

The immovable finger of the larger hand exceeds half the length of the movable one; on the cutting edge of the movable finger, near its base, there is a large, white bilobed or double tooth, while near the upper end of the cutting edge of the immovable finger there is a large tuberculiform tooth. The laminate anterior margin of the carpus is granulate along the edge, giving it a minutely denticulate appearance; rarely if ever is there any suggestion of larger teeth, other than the one comprising the entire laminate portion.

The telson is composed of five plates; a central (triangular), two terminal, and two lateral.

Dimensions.—Type, male: length of carapace 10.9 mm., width 11.7 mm.

Type Locality.—Monterey, California.

Distribution.—Kadiak, Alaska, to San Diego, California; Lower California (Lockington).

Pachycheles holosericus sp. nov.

Plate 33, figure 3

Description.—Chelipeds unequal, covered on upper surface with a dense, even, velvety pubescence, covering all but the more prominent tubercles and granules, which are arranged in three rows behind the large tubercle on the median distal portion of the palm and the tips and outer surfaces of the fingers, but filling the gape between the fingers of the larger hand. Pubescence in older specimens extends over the outer portion of the lower surface of the joints of the chelipeds.

There are two rows of granulated tubercles behind the large one near the gape of the fingers; one row of three or four lying in a line immediately behind it, and a second, usually of six, between this row and the row of sharply prominent granules, forming the upper edge of the outer margin of the palm. The large tubercle is approximately twice as high as wide at the base. On the cutting edge of the movable finger of the larger hand, near its base, is a single large, shining white tooth; the fixed or immovable finger is less than half the length of the movable one. The anterior, or inner margin of the carpus is laminate, and cut into a number of spine-tipped, deeply incised, laciniate teeth.

The telson, as in *P. rudis*, is composed of five plates: a central (triangular), two terminal, and two lateral.

The type specimen, a large ovigerous female (Cat. No. 50156, U. S. N. M.) was received from the Venice Marine Biological Station at Venice, California, under the number "Acc. 165." The carapace measures 18 mm. long and 19 mm. wide.

Distribution.—I have also seen specimens from Long Beach, Laguna Beach, La Jolla, and San Diego, California.

Pachycheles pubescens Holmes

Plate 33, figure 4

Pachycheles pubescens Holmes, Occas. Papers Calif. Acad. Sci., **7**, 110, 1900; Balss, Abh. der k. Bayer. Akad. Wiss., II, Math.-phys. Klasse, Suppl., 9 Abh., p. 32, figs. 22–23, 1913.

Fig. 112. *Pachycheles pubescens,* telson of large ♀, × 2.

Characters.—Chelipeds unequal, evenly rounded, not rugose or tuberculated, but quite uniformly granulated; granules completely or nearly hidden by the short, thick pubescence which covers the upper surface, extending almost to the tips of the fingers, filling the gape between them with a dense, bushy growth; interspersed are numerous tufts of longer, stiffer hairs, which arise from the anterior side of the bases of many of the granules.

On the cutting edge of the movable finger of the larger hand, near its base, there is a large, white, bilobed or double tooth; immovable finger is about half or less than half as long as the movable one. The laminate anterior edge of the carpus is cut into two to four roughly triangular teeth, armed with secondary denticles.

The telson composed of seven plates: a central (triangular), two terminal, and two lateral, each of which has a smaller plate separated off at its proximal end. These smaller plates together constitute a second pair of lateral plates which are characteristic of this species as compared with the other two listed above.

Dimensions.—Type: length of carapace 15 mm., width 15 mm.; of the largest specimen I have examined: length of carapace 18 mm., width 19 mm.

Type Localities.—Drake's Bay, Farallon Islands and Humboldt County, California.

Distribution.—From Port Orchard, Puget Sound, Washington, to Monterey Bay, California. I have seen specimens from both of these localities and Oakland, California, as well, where a single specimen was taken by Henry Hemphill. Misaki, Japan (Balss).

Genus **Petrolisthes** Stimpson

Carapace subovate; front triangular, with a more or less undulated margin, which may be either smooth or dentated; epimera (pleural, subbranchial, or lateral portions of the carapace) entire. First or basal joint of antennal peduncle very short, not reaching the upper margin of the carapace; the second joint is flattened and more or less cristate. Chelipeds equal or subequal, broad and flattened; carpus more or less elongated.

Key to the California Species of Petrolisthes

I. Carpus of chelipeds about twice as long as wide, or less; minutely granulated or finely tuberculated, never very rough.

A. Carpus with parallel anterior and posterior margins, about twice as long as wide; upper surface with irregularly scattered small and tiny tubercles; lobe at inner margin if present never very prominent and not interfering with parallelism of margins. Carapace finely striated over entire surface, except in cardiac region; anterior branchial and gastric regions with small, irregularly placed tubercles, which scatteringly follow the areolations. Merus of ambulatory legs hairy.

eriomerus, p. 180.

B. Carpus of chelipeds with sides not parallel, with a prominent lobe at inner angle, and a distinct distal convergence of anterior and posterior margins, almost invariably one and one-half times as long as wide; surface of carpus granulated rather than tuberculated, anterior margin usually smooth, lobe at inner angle well granulated. Carapace similar to preceding, but with a longitudinal convexity greater and more pronounced than any of the species here listed. Merus of ambulatory legs not hairy.

cinctipes, p. 179.

II. Carpus of chelipeds about two and one-third times as long as wide, or longer; anterior and posterior margins subparallel; carpus either very smooth or very rough.

A. Carpus very smooth, punctate, or minutely and almost imperceptibly scaled or tuberculated, more than two and one-half times as long as wide. Carapace smooth and flattened, though distinctly areolated, minutely striated on branchial regions, tending to become punctate elsewhere, never tuberculate. Merus of ambulatory legs not hairy. (Not known north of Monterey.)

gracilis, p. 181.

B. Carpus rough, covered with overlapping, scale-like rugae, between two and one-third and two and one-half times as long as wide. Carapace strongly rugose, broken up into scale-like projections, most prominent anteriorly, anterior edges of rugae piliferous. Ambulatory legs very hairy. (Not known north of San Pedro.)

rathbunae, p. 181.

Petrolisthes cinctipes (Randall)

Plate 32, figure 1

Porcellana cinctipes Randall, Jour. Acad. Nat. Sci. Phila., **8**, 136, 1839.

Porcellana rupicola Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 480, pl. 19, fig. 2, 1857.

Petrolisthes cinctipes Holmes, Occas. Papers Calif. Acad. Sci., **7**, 107, 1900; Rathbun, H. A. E., **10**, 168, 1904; Baker, Rept. Laguna Mar. Lab., **1**, 102, 1912.

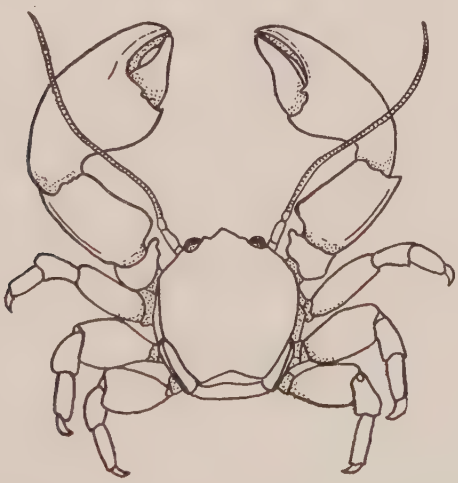


Fig. 113. *Petrolisthes cinctipes*, natural size.

Characters.—Carpus of chelipeds one and one-half times as long as wide, anterior and posterior margins distinctly convergent distally; anterior or inner margin with a prominent lobe at inner angle; general surface of carpus granulated rather than tuberculated; anterior margin usually smooth, lobe at inner angle well granulated. Carapace similar to *P. eriomerus* but with a greater and more pronounced longitudinal convexity. Merus of ambulatory legs not hairy.

Dimensions.—Type: length a little over 15.2 mm. Length of carapace of specimens collected in San Francisco Bay ranged from 2.5 to 13 mm., the greater number were about 11 mm. long.

Color.—Dark purplish red (Stimpson). Reddish brown anteriorly, blue posterolaterally; three posterior pairs of feet blue, fasciate with white (Randall).

Type Locality.—Sandwich Islands (doubtful).

Distribution.—From Vancouver Island, British Columbia, to the Gulf of California (Rathbun).

Remarks.—This species can always be distinguished by the short, stout carpus; by the fact that the merus joint of the ambulatory legs is not hairy and attains the greatest width, or dilation near the distal end, particularly in the third pair of legs. Baker states "the 'flat-crab' is common under stones between tides."

Biological Survey of San Francisco Bay.—This littoral species was only taken twice, one specimen among the rocks at Sausalito and four others in rocky places along the Richmond shore, north of the Standard Oil pier. Those from the latter locality are very small, juvenile specimens. *Petrolisthes cinctipes* is doubtless of more common occurrence than the above records, based on a very limited number of shore stations, seem to show, for Stimpson reported, "It is abundant in some parts of San Francisco Bay."

Petrolisthes eriomerus Stimpson

Plate 32, figure 2

Petrolisthes eriomerus Stimpson, Ann. Lyc. Nat. Hist. N. Y., **10**, 119, 1871; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 108, pl. 1, fig. 15, 1900.

Fig. 114. *Petrolisthes eriomerus,* cheliped (after Holmes).

Characters.—Carpus of chelipeds about twice as long as wide, anterior and posterior margins parallel, upper surface with irregularly scattered small and tiny tubercles; lobe at inner angle, if present at all, never prominent and not interfering with parallelism of margins. Carapace finely striated over entire surface, except in cardiac region; anterior branchial and gastric regions with small, irregularly placed tubercles, which scatteringly follow the areolations. Merus of ambulatory legs hairy.

Dimensions.—Largest of several specimens collected at Half Moon Bay, May 11, 1913, measured: length of carapace 10 mm., width 10.5 mm., length of carpus of cheliped 8 mm., width 3 mm.

Type Locality.—Mendocino, California.

Distribution.—From British Columbia to Lower California.

Remarks.—Differs from *P. cinctipes* in that the chelipeds are longer and smoother with narrower parallel-sided carpus, and in having hairy, less dilated merus joints of the ambulatory legs (Holmes).

Petrolisthes gracilis Stimpson

Plate 32, figure 4

Petrolisthes gracilis Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 74, 1859 (1862); Lockington, Ann. Mag. Nat. Hist. (5), 2, 396, 1878.

Characters.—Carpus of chelipeds long and narrow, about three times, or nearly three times as long as wide, anterior and posterior margins subparallel; upper surface very smooth, punctate, or at most very minutely and inconspicuously (microscopically) scaled or tuberculated. Carapace smooth and flattened, though distinctly areolated, minutely striated on branchial regions, tending to become punctate elsewhere, never tuberculate. Merus of ambulatory legs not hairy.

Dimensions.—Type: length of carapace 11.2 mm., width 10.4 mm. Of specimens in the U. S. National Museum: length of carapace 10 to 15 mm., width 9.5 to 16 mm.

Color.—Reddish (Stimpson).

Type Locality.—Guaymas, Mexico.

Distribution.—Monterey, Santa Catalina Island, and Pacific Grove, California; Guaymas, Mexico.

Petrolisthes rathbunae Schmitt

Plate 32, figure 3

Petrolisthes rathbunae Schmitt (MS), Hilton, Jour. Ent. Zool., Pomona Coll., 8, 72, fig. 6, 1916 (figure only, not specifically recognizable).

Description.—Entire animal quite rough, scabrous. Carapace strongly striated and rugose, rugae forming anteriorly directed scale-like projections and ridges, more pronounced at anterior end of carapace. Lines between rugae on carapace beset with short hairs, which are more thickly set on demarcation lines of areolations. Dorsal surface of carapace generally flat, with broadly triangular rostral process, sharply depressed from a line connecting the posterior margins of the orbits. Second segment of antennal peduncle slightly more than the length of the third, well scaled; segments of flagellum alternately furnished on lateral margins with long and short hairs. Upper and lower surface of chelipeds covered with squamiform tubercles, more prominent dorsally and on dorsal ridges. Carpus two and one-third to two and one-half times as long as wide, edges practically parallel, finely denticulated on anterior margin in adult; distinctly saw-toothed in young specimens. Posterior and ventral surface of carpus and entire merus covered with overlapping, scale-like rugae, which on carpus form a dorsal posterior ridge no rougher than general surface of carpus, and which ends distally in a tooth. The inner edge of the palm and outer edge of the movable finger are similarly scaled. Ambulatory legs and plates of abdomen scaled, as well as carpus, merus, and ischium of external maxillipeds. All joints of legs well beset with hairs, both edges of abdominal segments fringed with hairs, closely set short hairs interspersed with longer ones. Most hairy of west coast species of *Petrolisthes.*

Dimensions.—Type (Cat. No. 49176, U. S. N. M.), male: length of carapace 18 mm., width 17 mm., length of carpus of cheliped about 16 mm., width of carpus 6 mm.; of a female: length and width of carapace each 17 mm., length of carpus of cheliped 14 mm., width of carpus 5 mm.

Color.—A comparatively fresh specimen in formalin, received from Prof. W. A. Hilton, has a general ground color of salmon, fading out to a paler, more yellowish tint toward posterior edge of carapace, proximal portions of ambulatory

legs, and on under parts, becoming bluish white on sternum. Flagella of antennae transparent claret color. Larger scale-like projections of rugae on anterior portion of carapace and chelipeds spotted with brick red, the two to three spots of red to each of the scales on the carapace giving it an apparently tuberculated appearance. Hairs yellowish. A few scattered spots of brick-red occur on the first few abdominal segments.

Type Locality.—San Clemente Island, California (H. N. Lowe).

Distribution.—There are specimens in the United States National Museum from Monterey, Santa Monica, and San Pedro bays, and Santa Rosa, San Clemente, and Santa Catalina islands. I have also seen a specimen collected at Laguna Beach by Prof. W. A. Hilton of Pomona College.

Remarks.—This species has been named in honor and appreciation of Dr. Mary J. Rathbun, associate in zoology of the Smithsonian Institution.

In general appearance and coloration it resembles *P. agassizii* Faxon (Bull. Mus. Comp. Zool., **24**, 174, 1893; Mem. Mus. Comp. Zool., **18**, 69, pl. 15, fig. 1, 1895), but it is readily distinguishable in that it lacks the three teeth which are so prominent on the anterior border of the carpus of the chelipeds of that species.

Tribe BRACHYURA

Key to the Subtribes of the Brachyura

I. Mouth-field (endostome) triangular, narrowed in front, produced forward over epistome to form a gutter; efferent branchial channels opening at middle of endostome; third maxillipeds more or less narrow, not expanded into flat, lid-like structures as in other crabs. Carapace more or less circular. Female openings generally on sternum. First pleopods wanting in female.

Oxystomata, p. 185.

II. Mouth-field roughly square.

A. Last pair of legs abnormal, small, and subdorsal in position, as are often also the legs of the fourth pair. Antennae long, flagellum equal to more than one-half width of carapace; antennules without special fossettes; sometimes a common orbito-antennulary fossa present. Female openings coxal. First pleopods present in female. (Not known north of Monterey Bay.)

Dromiacea, p. 182.

B. Last pair of legs normal, rarely reduced, not dorsal. Antennae short, never equal to one-half width of the carapace; antennules usually lodged in special fossettes. Female openings sternal, rarely coxal. First pleopods wanting in female.

Brachygnatha, p. 191.

Subtribe DROMIACEA

Key to the Superfamilies and the California Families of the Dromiacea

I. Sternum of female with a pair of obliquely longitudinal grooves. Eyes and antennules almost always retractile into common orbito-antennulary pits. Rudimentary uropods usually present. (Superfamily *Dromiidea.*)

Dromiidae, p. 183.

II. Sternum of female without longitudinal grooves. Eyes not retractile into orbits nor antennules into pits. Uropods never present. (Superfamily *Homolidea.*)

Homolidae, p. 183.

Family Dromiidae

Carapace subglobular, rarely flattened; no *lineae anomuricae* (a pair of longitudinal suture lines on the carapace); sternum of female traversed for more or less of its extent by two obliquely longitudinal grooves. Eyes and antennules almost always retractile into common orbito-antennulary pits. External maxillipeds generally operculiform. Legs of moderate size, fourth and fifth pairs short, subdorsal in position, and furnished with a small, hook-like nail. Sixth segment of abdomen generally with rudimentary uropods.

Genus **Dromidia** Stimpson

Carapace convex and pilose, the hair being often of considerable length; front narrow, hepatic regions more or less concave, or excavated anteriorly. Sternal sulci in the female approximated at their extremities in either a single or more or less bifurcated tuberculiform projection, situated between the bases of the chelipeds.

Dromidia larraburei Rathbun

Plate 33, figure 1

Dromidia sarraburei Rathbun, Proc. U. S. Nat. Mus., 38, 553, pl. 48, fig. 4, 1910 (error for *larraburei;* named for Señor Don Carlos Larrabure y Correa).

Dromidia segnipes Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, p. 15, pl. 1, figs. 1–2, 1910.

Characters.—Densely covered with fur except ends of fingers and dactyli. Carapace high, subglobular; anterolateral margins directed toward the buccal angles and armed with four to six small teeth or tubercles; from the last tooth an oblique furrow runs across the branchial region; front vertical, tridentate. Chelipeds short, stout, equal; fingers deeply channeled inside, gaping at base. First and second pairs of ambulatory legs broad, dactyli with curved horny tip and a row of spines beneath; third and fourth pairs narrower, subdorsal, and prehensile, fourth shorter, dactyli strongly curved, fifth recurved, both folding against a spinous process on the propodus.

Dimensions.—Type, ovigerous female: length of carapace 28.2 mm., width 30 mm. Of specimens taken in Monterey Bay, by Weymouth, male: length of carapace 15 mm., width 15.7 mm., length of antennal flagellum 11 mm.; female: length of carapace 15.7 mm., width 16.3 mm., length of antennal flagellum 10 mm.

Color.—In alcohol yellowish tan, tips of chelipeds flesh color; color in life similar (Weymouth).

Type locality.—Bay of Sechura, west of Matacaballa, Peru, depth about 5 fathoms.

Distribution.—Also from Monterey Bay and Long Beach, California, Magdalena Bay, Lower California, and the Galapagos Islands, shallow water.

Family Homolidae

Carapace longer than broad, more or less quadrilateral, ovoid, or urn-shaped; *lineae anomuricae* (a pair of longitudinal suture lines on the carapace) usually present; sternum of female not longitudinally grooved. Eyes not retractile into orbits nor antennules into pits. External maxillipeds pediform or subpediform. Legs long and slender, only fifth pair dorsal and reduced in size. Uropods wholly absent.

Genus **Homola** Leach, Alcock

Carapace deep, longer than broad, more or less quadrilateral, or urn-shaped, with deep vertical sides; gastric region well demarcated and occupying the anterior half of the carapace; hepatic region well developed, hepatic (or antero-lateral) spine some distance behind the level of the supra-orbital spine; *linea anomurica* distinct and dorsal; front narrow, forming a rostrum, which is either entire or bifid, and has a spine, often of large size, on either side of its base. Propodus of last pair of legs dilated near basal end and never twice the length of the dactyl.

Homola faxoni sp. nov.

Plate 31, figure 7

Description.—Carapace more or less quadrilateral, exclusive of rostral spine, a little longer than broad, greatest width at about posterior fourth of carapace; entire surface more or less obscured by a rather thick, short pubescence.

The supraorbital spines, one on either side of the base of the rostrum, are quite stout, surpassing the rostrum both in size and length, and each on its upper or posterior margin is provided with two small, hooked spines. Behind and a little closer together than the supraorbital spines there are two much less prominent ones on the anterior part of the gastric region. External to each of these there is a spine of like size, about in line with the tubercle on the apex of the gastric convexity and the superior hepatic spine at the anterolateral angle of the carapace; a tubercle also between the median gastric tubercle and the outermost of the anterior gastric spines, one on each side. The hepatic region is well developed and below the stout spine at anterolateral angle of the carapace there is a smaller, inferior hepatic spine. Marking the lateral margin of the dorsal surface of the carapace behind the superior hepatic spine is a row of four slightly smaller spines on the branchial region, paralleling the *linea anomurica,* and decreasing in size from before backward. There are sundry other tubercles rather regularly arranged in more or less definite groups on the various regions of the carapace.

Hairs covering chelipeds and legs longer than those on carapace; row of sharp, hooked spines on upper margin of merus of all except the last pair of legs, the largest of the series overhanging the articulation with the carpus at the superior distal angle of the joint; a spine, similarly placed, occurs on the merus of the last pair of legs; fingers of chelipeds one-third the entire length of the hand, and dark colored.

Abdomen also thickly pubescent, two basal segments, each armed with a sharp median tubercle.

Dimensions.—Type, female (Cat. No. 53331, U. S. N. M.): length of carapace, including rostrum 45 mm., of rostrum 5 mm., greatest width of carapace 36 mm., length of last leg to distal extremity of propodus 66 mm., of next preceding leg to distal extremity of merus 47 mm.

Type Locality.—Off Point Loma, 67 to 73 fathoms ("Albatross" station 4309).

Distribution.—Only known from off Point Loma, about southwest eight to ten miles, 67 to 135 fathoms.

Remarks.—This species is most closely related to *Homola cuvieri* (Risso) (see Roux, Crust. Médit., p. 86, pl. vii, 1828, and Milne Edwards and Bouvier, Expéd. Sci. du *Travailleur* et *Talisman,* Crustacés décapodes, pt. 1, p. 10, 1910) of the

Mediterranean region, but the carapace is more quadrilateral, much more pubescent, and not so conspicuously and strongly granulated, being only finely and obscurely granulated beneath its pubescence.

In *H. cuvieri* the spines forming the lateral series on the branchial region behind the superior hepatic spine are six to eight in number, diminishing posteriorly to mere granulations; the inferior hepatic spine is the larger; there is a well defined median line of granulations containing two or three conspicuous spiniform tubercles, extending between the inner pair of the anterior gastric spines toward the rostrum, of which no counterpart exists in *H. faxoni;* also the legs of *H. cuvieri* are more slender and less flattened, the merus of the fourth leg, for example, measured on the flat, dorsally-turned side being almost seven times as long as wide, while the same joint in *H. faxoni* is only about five and one-half times as long as wide.

This species apparently belongs to the subgenus *Paromola* Alcock (1901, p. 61), but has a longer fifth leg than his definition admits; to be included that portion of Alcock's characterization would have to be slightly changed.

From the only other homolid of this subgenus on the west coast of America, *Homola* (*Paromola*) *rathbuni* Porter (Rev. Chilena Hist. Nat., **12**, 88, pl. viii, 1908), our species differs in having a more quadrilateral carapace and longer fifth legs as compared with Prof. Porter's figure, which was unaccompanied by a description owing to loss of the type by fire.

Subtribe OXYSTOMATA

Key to the California Families of the Oxystomata

I. Abdomen hidden under thorax; antennae small; legs normal in size and position. Carapace rounded and crab-like.

A. Afferent openings to gill chambers lie in front of the chelipeds; maxillipeds not completely closing buccal cavern, the palp always exposed. (Not known north of the Farallones.)

Calappidae, p. 190.

B. Afferent openings to gill chambers lie on either side of mouth at base of third maxillipeds; maxillipeds not completely closing buccal cavern, the palp hidden by triangular merus. (Not known north of Mendocino County.)

Leucosiidae, p. 187.

II. Abdomen not hidden under thorax; antennae large; last two pairs of legs reduced in size and articulated higher than preceding pair, so as to lie on dorsal surface of body, subprehensile, with hook-like end joints. Afferent openings to gill chambers near bases of the chelipeds. Carapace short and subcircular or more or less squarish. (Not known north of Santa Catalina Island or possibly Monterey.)

Dorippidae, p. 185.

Family Dorippidae

Abdomen not hidden under thorax. Carapace short, subcircular, or more or less squarish. Antennae large. Last two pairs of legs reduced in size and articulated higher than preceding pair, so as to lie on dorsal surface of body, subprehensile, with hook-like end joints. Afferent openings to gill chambers near bases of the chelipeds.

Genus **Cyclodorippe** Milne Edwards and Bouvier

Carapace subcircular; efferent (excurrent) openings to gill chambers contiguous, in a common channel which extends to the frontal margin. Antennules free and long; antennal peduncle narrow. No flagellum on the exopodites of the third maxillipeds. Eyes present, eye-stalks short and stout. Male and female genital openings coxal.

Cyclodorippe plana Rathbun

Cyclodorippe plana Rathbun, Amer. Nat., **34**, 519, 1900.
Clythrocerus planus Rathbun, H. A. E., **10**, 168, pl. 9, fig. 4, 1904; Nininger, Jour. Ent. Zool., Pomona Coll., **10**, 36, figs. 9 and 10, 1918.

a *b*

Fig. 115. *a*, *Cyclodorippe plana*, ♂, × 6; *b*, *Cyclodorippe*, ♂, sp.?, × 6 (from Rathbun, U. S. N. M.).

Characters.—Carapace subcircular, a little broader than long; dorsally flat, finely granulate, granules larger toward outer margin; the front is occupied by two triangular lobes, each tipped with a blunt tooth; lobes separated from each other by a broad ∨-shaped sinus, which is prolonged on dorsal surface by a broad, shallow depression continued to the gastric region; outer margin of each lobe slightly concave; outer orbital tooth narrow, blunt, well marked. A little in front of middle of lateral margin is a tooth somewhat larger than the orbital, directed forward and slightly outward; at one-third the distance from orbital to this branchial tooth is a much smaller triangular tooth directed outward. Anterior end of buccal cavern and of merus of outer maxillipeds project slightly in front of median sinus of front.

Dimensions.—Type, male: length of carapace to end of horns 3.4 mm., width 3.7 mm.; female: length 2.8 mm., width 3 mm.

Color.—Carapace speckled with small black spots; in alcohol (Rathbun).

Type Locality.—Southern California, either at Catalina or Monterey, doubtless the former, as another specimen has since been collected there.

Distribution.—The U. S. National Museum has recently received four other specimens, an ovigerous female taken off Point Fermin in 10 fathoms by the Venice Marine Biological Station, and two males and an ovigerous female collected at Laguna Beach by W. A. Hilton.

Remarks.—Another male (fig. *b* above) dredged at Santa Catalina Island in 1863 by Dr. J. G. Cooper, measuring 4.3 mm. long to end of horns and 4.2 mm. wide, differs notably from the more typical forms in the following particulars: "The frontal lobes are prolonged in cylindrical blunt spines; the upper orbital margin has an inner rectangular sinus, while the fissure next the outer tooth is larger than in the typical form; the first tooth of the lateral margin is nearer the posterior tooth, than it is to the orbital tooth; the surface is more uneven, and more coarsely granulate. The legs are absent. I think the differences are not those of age, and indicate a distinct species, to which, however, I hesitate to give a name on account of the poor condition of the specimen" (Rathbun, 1904*a*, p. 169).

... these crabs surely receive their full share of attention in the aquarium. They persist in carrying about upon their backs pieces of shell, pebbles, sticks, fragments of seaweed, or entire shells with their living contents, and seem much embarrassed without some such covering. When placed in a glass dish where nothing else was available, one seized a snail shell more than twice its own size and seemed perfectly content when it had this firmly gripped upon its back. They are found in 15–20 fathoms of water on gravel and shell beds. The two rear pairs of legs are peculiarly modified into upturned hooks for gripping objects carried on their backs. And the dorsal surface of the carapace is reduced to a plane (Nininger).

Family Leucosiidae

Carapace crab-like; more or less rounded, very hard, afferent (incurrent) openings to gill chambers lie on either side of mouth at base of third maxillipeds. Third maxillipeds completely close the buccal cavern; the three terminal joints (constituting palp) wholly concealed by the triangular fourth (merus) joint. Antennae small. Legs normal in size and position. Abdomen hidden under the thorax. Male and female genital openings sternal.

Genus **Randallia** Stimpson

Carapace strongly convex, subhemispherical, evenly rounded at sides, with two lobes or teeth at posterior margin. Front narrow, very short, with a concave anterior margin. Merus of third maxillipeds subtriangular, not much shorter than the ischium, reaching nearly as far forward as the front. Chelipeds rather long; merus subcylindrical; hand narrow; fingers acute and somewhat compressed. Ambulatory legs of moderate length; joints not dilated; dactyls styliform.

Key to the California Species of Randallia

I. Carapace of adult nearly smooth, sensibly longer than wide; space between posterior median pair of spines or tubercles less than between median and lateral. Young with unequal, more or less rough tubercles.

ornata, p. 188.

II. Carapace covered with large, pearly, beadlike, more or less equal tubercles; carapace suborbicular, but slightly longer than wide; space between posterior median pair of spines or tubercles greater than between median and lateral. (Not known north of San Diego.)

bulligera, p. 189.

Randallia ornata (Randall)

Ilia ornata Randall, Jour. Acad. Nat. Sci. Phila., **7**, 129, 1839.

Randallia ornata Stimpson, Jour. Boston Soc. Nat. Hist., **6**, 471, pl. 19, fig. 3, 1854; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 100, 1900; Rathbun, H. A. E., **10**, 170, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, p. 18, pl. 1, fig. 3, 1900; Baker, Rep. Laguna Mar. Lab., **1**, 102, 1912.

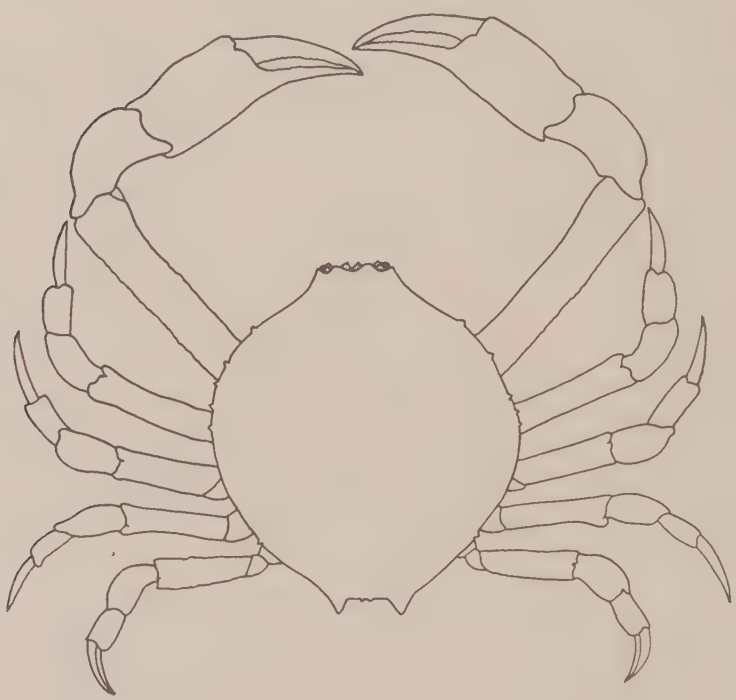


Fig. 116. *Randallia ornata*, natural size.

Characters.—Carapace of adult nearly smooth, but furnished anteriorly with a few scattered granules and a few larger granulations at the sides; sensibly longer than wide; there is a small tubercle on the posterior portion of the branchial region; posterior margin of carapace elevated, granulated and furnished with two pointed tubercles; space between posterior median pair of spines or tubercles less than between median and lateral. Young with quite numerous, unequal and more or less rough tubercles.

Dimensions.—Type, female: length 30.5 mm. The carapace of the only specimen taken in connection with the Survey was 43 mm. in length.

Color.—Disk variegated with sanguineous spots confluent anteriorly; anterior feet variegated with red (Randall). The carapace is of a light color marbled with reddish patches which are larger in front (Holmes).

Type Locality.—California.

Distribution.—From Mendocino County, California, to Magdalena Bay, Lower California; 5½ to 51 fathoms (Rathbun).

Remarks.—Varies greatly in the prominence of the granules on the carapace (Rathbun).

Biological Survey of San Francisco Bay.—One specimen of *Randallia ornata* was taken outside of San Francisco Bay in 10 to 30 fathoms, April 6, 1914, while making several experimental trials with a 40-foot otter-trawl.

Randallia bulligera Rathbun

Randallia bulligera Rathbun, Proc. U. S. Nat. Mus., **21**, 614, pl. 44, fig. 6, 1898; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 101, 1900; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, p. 19, 1910.

Fig. 117. *Randallia bulligera*, ♂, × 1⅔ (from Rathbun, U. S. N. M.).

Characters.—Carapace covered with large, pearly, bead-like, more or less equal tubercles; carapace suborbicular, but slightly longer than wide; space between posterior median spines or tubercles greater than between the median and lateral. Anterolateral angles of the buccal cavity produced in front of the orbital margin and deeply three-lobed.

Dimensions.—Type, male: length on median line 11.6 mm., width 11.5 mm.; ovigerous female: length 12.8 mm., width 12.6 mm.

Color.—Much as in *R. ornata.*

Type Locality.—Magdalena Bay, Lower California, 12 fathoms.

Distribution.—Off San Diego, California, 30 fathoms (Holmes), and Magdalena Bay, Lower California, 12 fathoms (''Albatross'' station 2831) (Rathbun); Monterey Bay, 10 fathoms (Weymouth).

Remarks.—I am inclined to think that the specimens called *R. bulligera* by Weymouth are especially rough-coated young of *R. ornata.* For as Holmes remarks the former is ''easily distinguished from *ornata* by the numerous beadlike tubercles on the carapace and the lobes at the anterior end of the buccal area.''

Family Calappidae

Carapace rounded, crab-like; afferent (incurrent) openings to gill chambers lie in front of the chelipeds. Third maxillipeds do not completely close the buccal cavern; palp of maxillipeds always exposed. Antennae small. Legs normal in size and position. Abdomen hidden under the thorax. Male genital openings coxal, female sternal.

Genus **Mursia** Leach, Desmarest

Carapace strongly convex, transversely oval, with a strong lateral spine on each side; front narrow. Chelipeds large; when folded fitting close to the body; hands large, compressed distally, widened, surmounted by a laminate and dentate crest, and furnished with a longitudinal, granulated ridge near the lower side of the outer surface.

Mursia gaudichaudii (Milne Edwards)

Platymera gaudichaudii Milne Edwards, Hist. Nat. Crust., **2**, 108, 1837; Milne Edwards and Lucas, *in* D'Orbigny's Voy. dans l'Amér. Mér., **6**, pt. 1, p. 28, 1843, pl. 13, 1847; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 99, 1900; Rathbun, H. A. E., **10**, 170, 1904.

Mursia gaudichaudii Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 19, 1910.

Fig. 118. *Mursia gaudichaudii* (after Milne Edwards and Lucas).

Characters.—Carapace strongly convex; anterior margin of front truncated and strongly concave when seen from in front; postorbital tooth very small; anterolateral margin regularly arcuated, armed with about fifteen small teeth separated by concave interspaces; lateral spine large, straight, subcylindrical. Hands of chelipeds furnished with several small tubercles on outer surface; ridge on lower portion of outer surface very large, bearing a small tooth near proximal

end; superior crest more or less hairy, armed with six teeth; there is a granulated ridge on the lower side of hand; immovable finger short, subtriangular, flattened, depressed; outer margin of movable finger prominent, granulated, when closed is at right angles to the palm.

Dimensions.—Type: length 76.2 mm.; of specimen examined by Holmes: length of carapace 41 mm., width between tips of lateral spines 79 mm., length of lateral spine 12 mm.

Color.—Reddish (Milne Edwards).

Type Locality.—Coast of Chile.

Distribution.—From the Farallon Islands, California, to Chile; 26 to 218 fathoms.

Subtribe BRACHYGNATHA

Key to the Superfamilies of the Brachygnatha

I. Fore part of body narrow, usually forming a distinct pointed or spined rostrum; carapace more or less triangular, branchial region inflated, hepatic small. Orbits usually incomplete.
Oxyrhyncha, p. 191.

II. Fore part of body broad; rostrum usually reduced or wanting; carapace usually wide, oval, round or square, never with hepatic region greatly reduced. Orbits nearly always well enclosed.
Brachyrhyncha, p. 216.

Superfamily Oxyrhyncha

Key to the California Families of the Oxyrhyncha

I. Chelipeds rarely much greater than other legs, very mobile. Basal joint of antennae well developed, usually fused with epistome and often with the front. Orbits usually more or less incomplete.
Inachidae, p. 192.

II. Chelipeds very much longer and heavier than other legs, not especially mobile. Basal joint of antennae small, short, and not fused with epistome or front. Orbits well formed, complete. (Not known north of the Gulf of the Farallones.)
Parthenopidae, p. 191.

Family Parthenopidae

Basal joint of antennae (more correctly the coalesced second and third joints) small and short, not fused with the epistome or front, imbedded with the next joint in the narrow hiatus between the front and the inner suborbital angle; infra-ocular space is mainly occupied by the lower wall of the orbit. Orbits well formed, complete. Chelipeds much longer and heavier than other legs, not especially mobile.

Genus **Heterocrypta** Stimpson

Carapace triangular, transverse, lateral margins greatly produced and concealing the ambulatory legs; a conspicuous depression separating gastric from cardiac and branchial regions; rostrum simple; pterygostomian region with a strongly marked ridge. Chelipeds greatly developed, trigonal.

Heterocrypta occidentalis (Dana)

Cryptopodia occidentalis Dana, Amer. Jour. Sci. (2), 18, 430, 1854.
Heterocrypta occidentalis Holmes, Occas. Papers Calif. Acad. Sci., 7, 44, 1900; Rathbun, H. A. E., 10, 170, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 21, pl. 2, figs. 4–5, 1910.

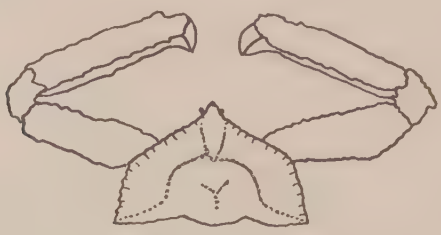


Fig. 119. *Heterocrypta occidentalis*, ♂, × ⅘ (after Dana).

Characters.—Carapace broadly triangular; rostrum triangular, subacute, not depressed; median region narrow, flattened upper surface bounded by two granulated ridges, which converge to a point behind; cardiac region furnished with a three-sided, pyramidal elevation, edges of which are usually granulated; posterior margin of carapace not produced over the abdominal segments. Outer portion of orbit with a superior and an inferior fissure. Chelipeds long, trigonal; hand about as long as merus, angles prominent and dentate, sides concave; immovable finger short, deflexed; movable finger short but longer than immovable one, when closed its outer margin nearly at right angles to the long axis of the hand.

Dimensions.—Type: width of carapace 31.8 mm.

Color.—Reddish (Holmes). Tips of tubercles white, ridges bearing tubercles a light purplish hue, remainder of carapace mottled with numerous minute spots of white and purplish tint, giving a pink effect which closely approaches white. Ambulatory legs usually a light yellow (Weymouth).

Type Locality.—Monterey, California.

Distribution.—From Gulf of the Farallones to San Diego, California, and Los Coronados Islands; 13 to 36 fathoms (Rathbun).

Family Inachidae (Maiidae)

Basal joint of antennae (more correctly the coalesced second and third joints) well developed, usually fused with the epistome and often with the front, usually occupying a great part of the infra-orbital space. Orbits usually more or less incomplete. Chelipeds rarely much greater than other legs, very mobile.

Key to the California Genera of the Inachidae

I. Basal joint of antennae extremely slender throughout its length and usually long. Length of basal antennal joint, measured from raised margin of endostome to insertion of free joints, greater than or at least equal to the combined width of the joints and that portion of the epistome or antennular fossettes lying between them, measured from bases of eye-stalks (middle of lower orbital margin). Eyes without orbits and not concealed. Rostrum simple except in *Oregonia*, in which it is bifid.

A. Rostrum simple.

1. Postocular spine small and distant from the eye or absent.

a. Chelipeds fairly short and stout, dactyl about one-half total length of hand, no supraocular spine. Carapace not spiny, elongate, pyriform, narrowed in front; hepatic region tumid, with two not very prominent tubercles, the larger above and in front of the smaller. (Not known north of Monterey Bay.)

Podochela, p. 195.

b. Chelipeds long and slender, dactyl about one-fourth total length of hand; a prominent supraocular spine. Carapace spiny. (Not known north of Monterey.)

Anasimus, ♂, p. 196.

2. Postocular spine prominent and close to eye. Chelipeds moderately short and stout, dactyl about one-half total length of hand.

a. A prominent acute, supraocular spine. Carapace spiny. A low tubercle or spine on first abdominal joint. (Not known north of Monterey.)

Anasimus, ♀, p. 196.

b. Upper margin of orbit prominent, but without supraocular spine. Carapace furnished with tubercles and granulations. A prominent spine-like tubercle on first abdominal joint. (Not known north of Monterey Bay.)

Inachoides, p. 199.

B. Rostrum bifid, composed of two long, slender, contiguous spines. Postocular spine prominent, slender, acute, inclined forward and situated some distance behind orbit. Chelipeds rather slender, dactyl about one-half total length of hand. (Not known south of Monterey Bay.)

Oregonia, p. 198.

II. Basal joint of antennae not extremely slender, often very wide. Length of basal antennal joint less than distance between lower orbital margins; usually in the proportion of two to three. Rostrum bifid except in *Epialtus*, where it may be either bifid or simple.

A. Basal joint of antennae truncate-triangular. Eyes without true orbits, eye-stalks very short, either concealed beneath a supraocular spine, or sunk in the sides of a huge beak-like rostrum. Postocular spine, if present, with anterior face convex or flattened so that cornea of retracted eye is always visible from above. Exognath of outer maxillipeds widest in distal half, tapering abruptly.

1. Antennae concealed beneath the rostrum. Lateral margins of carapace not markedly flattened or produced. Surface of carapace smooth or undulated. Rostrum bifid or simple.

Epialtus, p. 200.

2. Antennae not concealed beneath the rostrum. Rostrum bifid.

a. Lateral margins of carapace not markedly flattened or produced; with two large lobes or teeth on each side; upper surface with spines or tubercles.

Pugettia, p. 205.

b. Lateral margins of carapace markedly flattened and produced, entire lateral portions of carapace wing-like; upper surface smooth or nearly so.

Mimulus, p. 204.

B. Basal joint of antennae usually either extensively produced outward or with one or more distal spines. Eyes with orbits. Postocular spine cupped, or with dense growth of hair on anterior face so that cornea of retracted eye is partially concealed from above. Exognath of outer maxillipeds widest in basal half, tapering gradually. Rostrum bifid.

1. No preocular spine.
   a. Carapace but slightly longer than wide; surface uneven, tuberculated or spiny. Rostrum short, flattened, and notched.
   Chionoecetes, p. 209.
   b. Carapace much longer than wide; surface smooth, devoid of spines. Rostrum composed of two narrow, divergent spines, united basally, for half their length. (Not known north of San Pedro.)
   Pelia, p. 210.
2. A preocular spine.
   a. Postocular spine flattened and densely hairy on anterior face. Carapace with numerous or very prominent tubercles or spines. Rostrum bifid. (Not known north of Point Reyes.)
   Loxorhynchus, p. 212.
   b. Postocular spine deeply cupped on anterior face and without hairs.
      i. Rostrum composed of two long, slender, straight, cylindrical spines, diverging from the base. Carapace pyriform, inflated, and covered with sharp spines of unequal length.
      Chorilia, p. 208.
      ii. Rostrum composed of two short, flattened horns.
         a. Rostral horns extremely flattened and leaf-like, about one-quarter length of carapace. Orbits deep. Outer margin of basal antennal joint flattened and produced, not spiny. Carapace subpyriform, furnished with rounded tubercles.
         Scyra, p. 213.
         b. Rostral horns very short, one-ninth to one-tenth length of carapace. Orbits shallow. Outer margin of basal antennal joint not produced, spiny. Carapace suborbicular, tuberculated. (Not known north of Monterey Bay.)
         Herbstia, p. 215.

As can be seen from a review of the above key, the genera of the Inachidae arrange themselves into two major groups, based on the proportions of the basal antennal joints. In order to facilitate the presentation of generic definitions, they are so grouped below:

I. Basal joint of antennae extremely slender throughout its length and usually long; length measured from raised margin of endostome to insertion of free joints greater than or at least equal to the combined width of the joints and that portion of the epistome or antennular fossettes lying between them, measured from bases of eye-stalks (middle of lower orbital margin). (Group II, p. 200.)

Genus **Podochela** Stimpson

Carapace somewhat depressed, elongate triangular; gastric region narrow, swollen. Rostrum short, entire, triangular or arcuate; basal article of antennae very narrow, longitudinally sulcate in the middle. Eyes projecting laterally; postorbital tooth remote from eye, either well developed or reduced to a granule. Sternum of male either nearly smooth or deeply channeled between the segments; of female concave, deep, margins elevated, laminate, forming a capsule. Abdomen of male with last two segments and of female with last three segments coalesced, counting telson. Chelipeds of moderate length, merus curved, trigonal; palm either slender or dilated. Ambulatory legs slender, subprehensile.

Podochela hemphillii (Lockington)

Microrhynchus hemphillii Lockington, Proc. Calif. Acad. Sci., **7**, 30, 1877.
Podochela hemphillii Holmes, Occas. Papers Calif. Acad. Sci., **7**, 17, 1900; Rathbun, H. A. E., **10**, 171, pl. 10, fig. 2, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, p. 26, pl. 2, fig. 6, 1910; Nininger, Jour. Ent. Zool., Pomona Coll., **10**, 39, fig. 14, 1918.

Fig. 120. *Podochela hemphillii*, ♂, × 1¼ (from Rathbun, U. S. N. M.).

Characters.—Carapace pyriform; gastric region prominent, rounded, and bearing tufts of curved setae; hepatic regions tumid, bearing two not very prominent tubercles, the larger above and in front of the smaller; cardiac region separated by shallow grooves from the branchial and bearing a prominent elevation; branchial regions flattened or tumid. Rostrum variable in length, sometimes broadly, sometimes narrowly triangular, acute, and bearing two double rows of

curved setae above. No supraocular tooth or spine; the area between the two projecting rims of the orbits is concave; there is no tooth at the posterior margin of orbit, but there may be a small one a short distance behind it. Basal joint of antennae with a longitudinal ridge on its posterior half or two-thirds with a groove on either side. Chelipeds of male robust; hand oblong, incurved, palm inflated, fingers shorter than the palm, gaping at base and meeting along distal half or two-thirds of their length; chelipeds of female are smaller and more slender; hands subcylindrical, fingers nearly straight.

Dimensions.—Type, male: length 19.1 mm., width 8.4 mm.

Type Locality.—San Diego, California.

Distribution.—From Monterey Bay, California, to Gulf of California. Recorded from 8 to 47 fathoms, and perhaps occurs in shallower water (Rathbun).

Remarks.—This species was fairly common among the masses of red seaweed dredged from a depth of 10–20 fathoms. They are marked with reddish brown, but are always so covered over with decorative fragments of seaweed that even their form is almost indistinguishable. In the aquarium these creatures were very interesting. Their principal occupation was that of decorating themselves. Seizing a fragment near one end, that end was thrust into the mouth and chewed for some time, then transferred to some part of the carapace or legs, and by means of a peculiar and oft repeated twisting movement of the head [hand?] it was so firmly fastened that it would under almost all circumstances remain in the position in which it had been placed. The chewing led us to suspect a cementing element in the saliva, but on examination of the carapace it was found that each piece of seaweed was impaled on several of the stiff recurved hairs which occur in clumps over the carapace and legs (Nininger).

Genus **Anasimus** Milne Edwards

Carapace pyriform, convex, regions well defined; rostrum simple, slender; postorbital and supraorbital spine present. Basal article of antennae long and narrow, with spine at distal end. Abdomen and sternum granulate. Ambulatory legs very slender, decreasing more or less in length from first to fourth pairs, about twice, or more than twice, the length of the carapace; dactyls long.

Anasimus spinosus (Rathbun)

Erileptus spinosus Rathbun, Proc. U. S. Nat. Mus., **16**, 227, 1893; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 21, 1900; Rathbun, H. A. E., **10**, 171, pl. 10, fig. 1, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, p. 27, pl. 3, fig. 7, 1910.

Anasimus rostratus Rathbun, Proc. U. S. Nat. Mus., **16**, 226, 1893; H. A. E., **10**, 171, pl. 10, fig. 4, 1904.

Characters.—Carapace spinous; two spines on the median line, one on posterior part of gastric region, the other on cardiac; there are two spines on each branchial region and one on each protogastric region; lateral margins spinulous; rostrum slender, spinulous on margin; supraorbital spine prominent; postorbital spine in male small and at some distance from the eye, in female prominent and close to eye, defining the orbit. Chelipeds of male long and slender, about three times as long as carapace; hand slender, slightly flattened vertically, increasing in width toward distal end; fingers arched, gaping for one-half their length; dactyl about one-fourth total length of hand. Chelipeds of female weak, about one and one-half times as long as carapace; hands granulous; fingers nearly as long as palm (about one-half total length of hand), not gaping, in contact.

Fig. 121. *Anasimus spinosus; a*, ♂, × 3⅜; *b*, ♀, × 5 (from Rathbun, U. S. N. M.).

Dimensions.—Types, male: length 10 mm., width 6 mm., length cheliped about 28 mm.; female: length 7.5 mm., width 5 mm.

Type Locality.—Off San Diego, California, 36 fathoms ("Albatross" station 2934).

Distribution.—Monterey Bay or Santa Catalina Island; and from San Pedro to San Diego, California, to a depth of 36 fathoms; also northwest of Cerros Island, Lower California, 58 fathoms.

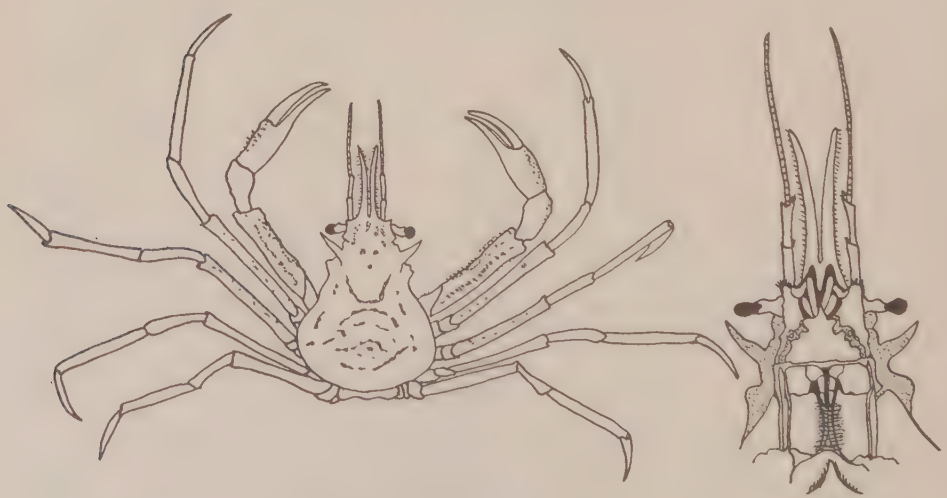
Remarks.—It is through the kindness of Miss Rathbun that I am able to here unite *Anasimus* and *Erileptus*. In working over material of these genera collected by the Venice Marine Biological Station she discovered their identity; *Erileptus spinosus* proved to be the male of *Anasimus rostratus*.

Genus **Oregonia** Dana

Carapace flattened, not spinose. Rostrum consisting of two long, slender, contiguous spines. Postocular spine present, prominent. Chelipeds rather slender, length variable. Ambulatory legs of moderate length, penultimate joint similar to preceding one, not dilate and compressed.

Oregonia gracilis Dana

Oregonia gracilis Dana, Amer. Jour. Sci. (2), **11**, 270, 1851; Crust. U. S. Expl. Exped., **1**, 106, 1852, pl. 3, fig. 2, 1855; Doflein, S. B., Math.-phys. Klasse, K. Abh. der Bayer. Akad. Wiss., **29**, 183, 1899; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 19, 1900; Rathbun, H. A. E., **10**, 171, 1904; Way, Puget Sd. Mar. Sta. Publ., **1**, 369, fig. 20, 1917.



a *b*

Fig. 122. *Oregonia gracilis*, ♂; *a*, dorsal view, × 4/5; *b*, ventral view of anterior portion, × 1⅗ (after Dana).

Characters.—Carapace subtriangular, more or less setose and roughened by minute prominences; median, cardiac, and branchial regions tumid. Rostrum bifid, composed of two long, slender, contiguous spines; postocular spine promiment, slender, acute, inclined forward and situated some distance behind the orbit.

Chelipeds rather slender; hand long, slender, smooth, incurved; dactyl about one-half total length of palm.

Dimensions.—Type, male: length of carapace 30.2 mm., width 21.2 mm. The specimen taken outside of Golden Gate measured, carapace and rostrum over all, 28 mm.

Color.—Tan or gray, with dots and small markings of red; color however cannot be seen until decorative material is removed (Way).

Type Locality.—Puget Sound.

Distribution.—From Bering Sea at Nunivak and Bering Island, to Monterey Bay; 5 to 135 fathoms. Japan (Balss).

Biological Survey of San Francisco Bay.—*Oregonia gracilis* though not taken in connection with any of the regular bay stations was obtained in July, 1912, by Mr. Johnston while observing the trawling operations of the A. Paladini Company on the fishing grounds outside of Golden Gate (approximately located in the general vicinity of D 5785–5787, 39 to 41 fathoms). The only temperature records available for the fishing grounds were made in October of the same year when the bottom temperature ranged from 9.8° to 11.0° C, and the salinity 33.8 to 34.2.

Genus **Inachoides** Milne Edwards and Lucas

Carapace longer than broad, cardiac, branchial and gastric regions swollen. Rostrum short and simple, with triangular base terminating in a spine; basal article of antennae with an antero-external tooth. No supraocular spine, postocular present, usually well developed and directed forward. Merus of outer maxillipeds cut at the antero-internal angle for the insertion of the palp; antero-external angle rounded. Abdomen of male with last two segments and of female with last three segments coalesced, inclusive of the telson; first segment armed with a spine or spine-like tubercle. Chelipeds enlarged, palms swollen; ambulatory legs slender, moderately long, first pair longest; subprehensile, propodal joints more or less enlarged distally; dactyls curved, folding against the propodi.

Inachoides tuberculatus (Lockington)

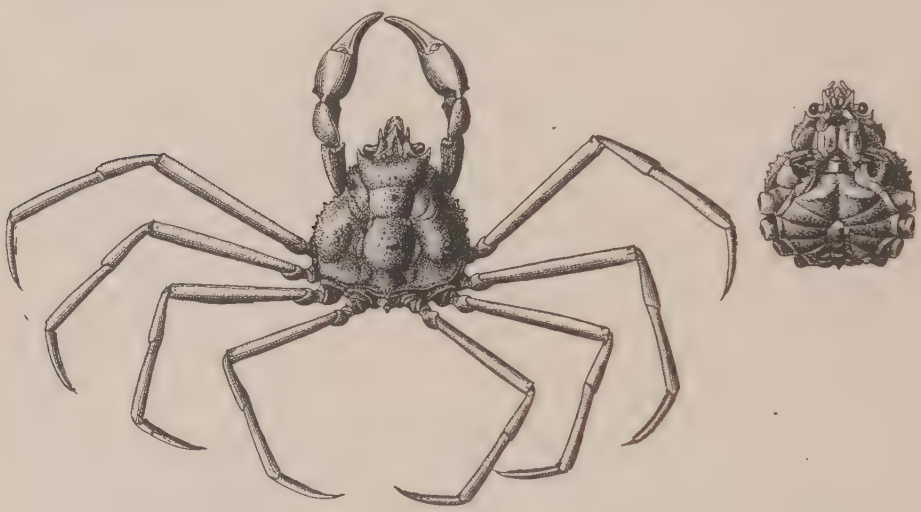
Inachus tuberculatus Lockington, Proc. Calif. Acad. Sci., 7, 30, 1877.

Inachoides magdalenensis Rathbun, Proc. U. S. Nat. Mus., 16, 228, 1893; H. A. E., 10, 171, 1904.

Dasygyius tuberculatus Holmes, Occas. Papers Calif. Acad. Sci., 7, 27, 1900; Rathbun, H. A. E., 10, 172; fig. 92, pl. 10, figs. 3, 3*a*, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 27, pl. 3, fig. 8, 1910.

Characters.—Carapace broadly triangular, pyriform, convex; surface granulate and tuberculate, with fine pubescence; tubercles tend to become spinous on lateral margins and on summit of branchial regions; on median line there is a spiny tubercle on the posterior part of gastric region, and a stout, spine-like tubercle on cardiac and on intestinal region. The median spines present in adult males become tuberculate in females and in smaller specimens, and the gastric tubercle is often absent. There is also a shorter spine-like tubercle on first

abdominal segment, pointing upward and backward. Rostrum acute; tips of post-orbital spines pointing forward; upper margin of orbit prominent but without supraocular spine. Basal antennal joint with outer margin prolonged into a slightly incurved spine. Sternum conspicuously granulate, or tuberculate, pubescent, deeply grooved between segments. Chelipeds of male short, rather stout, granulate; hand broad, inflated; fingers nearly as long as palm, gaping at base. Chelipeds of female more slender than in male; margins of hand parallel; fingers slightly gaping.



a *b*

Fig. 123. *Inachoides tuberculatus*, ♂, × 1½; *a*, dorsal; *b*, ventral view (from Rathbun, U. S. N. M.).

Dimensions.—Types, male: length 19.1 mm., width 14 mm.; female: length 14.2 mm., width 9.7 mm.

Type Locality.—San Diego Bay, California.

Distribution.—From Monterey Bay, California, to Panama Bay, Panama, 4 to 45 fathoms (Rathbun).

Remarks—Inachoides magdalenensis and *Dasygyius tuberculatus* are apparently one and the same species, and at Miss Rathbun's suggestion I have here combined them.

II. Basal joint of antennae not extremely slender, often very broad; length less than the distance between lower orbital margins, usually in the proportion of two to three. (Group I, p. 194.)

Genus **Epialtus** Milne Edwards

Carapace smooth or slightly tuberculated; margins not incised, with two or more lateral projections, sometimes very largely developed. Rostrum broad, triangular or oblong, bifid, or two spined, or entire. Basal antennal joint enlarged at base and narrowing distally; flagellum of antennae concealed beneath the rostrum. Preocular spine present or absent. Ambulatory legs stout, subcylindrical.

KEY TO THE CALIFORNIA SPECIES OF EPIALTUS

I. First tooth of the anterolateral margin large and prominent. Sides of carapace in front of posterior lateral teeth nearly parallel.

A. Rostrum obtuse, triangular, entire; no postocular spine. (Not known north of Monterey or Catalina Harbor.)

bituberculatus, p. 203.

B. Rostrum bifid, a small postocular spine, and a small triangular preocular spine.

productus, p. 201.

II. First tooth of the anterolateral margin small, not prominent. Sides of carapace convergent anteriorly between the two pairs of lateral teeth. Rostrum prominent, depressed, flattened above and having a small, triangular notch at the tip. No preocular spine, postocular small. (Not known north of Santa Barbara.)

nuttallii, p. 202.

Epialtus productus Randall

Epialtus productus Randall, Jour. Acad. Nat. Sci. Phila., **8**, 110, 1839; Rathbun, R., The Fisheries and Fishery Industries of the U. S., sec. 1, 778, pl. 268, 1884; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 22, pl. 1, fig. 1, 1900; Rathbun, H. A. E., **10**, 173, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 28, fig. 9, 1910; Baker, Rep. Laguna Mar. Lab., **1**, 100, 1912.

Fig. 124. *Epialtus productus*, × about ⅔ (from Rathbun, R., U. S. N. M.).

Characters.—Carapace smooth, sides in front of posterior lateral teeth nearly parallel; first tooth of anterolateral margin large and prominent. Rostrum bifid, deeply notched, inner margins of the horns slightly concave, outer convex. Preocular spine small, triangular; postocular also small. Chelipeds stouter and except in old males shorter than first ambulatory legs; hand long and narrow, palm oblong, subcarinate above, becoming inflated with age; fingers slender, bent

downward and curved inward, inner margins dentate and contiguous throughout their length, except in old males, in which they may become more or less gaping at the base.

Dimensions.—Type, female: length of carapace, inclusive of rostrum, about 44.5 mm. Large male: length, tip of rostrum to back of carapace 170 mm., width at first anterolateral tooth 84 mm., length of chelipeds 195 mm.; large female: length 92 mm., width 78 mm., length of chelipeds 90 mm. (Weymouth). Length of carapace for the Bay specimens ranged from 3 to 67 mm., mostly about 25 mm.

Color.—In life color varies from dark brown to tan, the lighter shades being found in young and apparently recently moulted individuals, in which also the dark spots mentioned by Holmes are inconspicuous or absent. Under parts reddish, often bright brick red, sometimes with light markings on the coxae of the ambulatory legs and on the external maxillipeds (Weymouth). Color reddish brown to olive brown, mottled with small, round spots of a darker hue (Holmes).

Type Locality.—California.

Distribution.—From British Columbia to Lower California (Rathbun).

Remarks.—There may be small, setose tubercles on the median region of young specimens, but they disappear with age, and there are two rows of curved setae on the upper side of the rostrum which persist for a longer time. Old specimens are almost devoid of hairs or setae of any kind (Holmes).

The young of the "kelp crab" are very common in the tide pools, clinging to *Fucus* and other brown algae, but mature specimens are found only in the kelp beds (Baker).

Biological Survey of San Francisco Bay.—Epialtus productus was only found in or near large patches of kelp: four fairly large specimens were taken August 1, 1912, below the low tide mark, from the extensive beds east of Point Bonita; one very large, one medium sized, and nine very small specimens, all told, were obtained on various occasions from the more or less abundant growths of kelp along the Sausalito shore; and one small specimen was dredged in 2 to 3 fathoms (D 5778), in the vicinity of the kelp patches off the rocky portions of the Presidio shore, east of Fort Point.

Epialtus nuttallii Randall

Epialtus nuttallii Randall, Jour. Acad. Nat. Sci. Phila., 8, 109, pl. 3, 1839; Holmes, Occas. Papers Calif. Acad. Sci., 7, 23, 1900; Rathbun, H. A. E., 10, 173, 1904.

Characters.—Carapace ovate, convex, smooth; first tooth of anterolateral margin small, not prominent, sides of carapace convergent anteriorly between the two pairs of lateral teeth. Rostrum prominent, depressed, flattened above, and having a small triangular notch at the tip. No preocular spine, postocular small.

Dimensions.—Type, male: length of carapace about 101.6 mm., inclusive of rostrum, greater width a little over 76.2 mm., female but half the size.

Color.—Dark purplish color, besprinkled with testaceous spots, becoming large and somewhat ocellate behind, and still larger and brighter on the under side of the body (Randall).

Type Locality.—California.

Distribution.—From Santa Barbara to Ballenas Bay, Lower California (Rathbun).

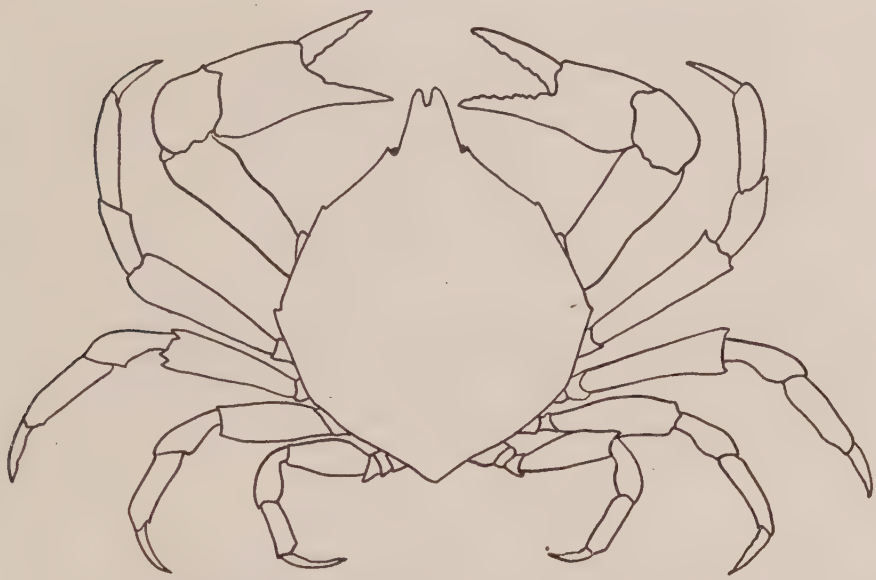


Fig. 125. *Epialtus nuttallii*, ♀, × ⅔ (after Randall).

Epialtus bituberculatus Milne Edwards

Epialtus bituberculatus Milne Edwards, Hist. Nat. Crust., **1**, 345, pl. 15, fig. 11, 1834; Rathbun, Bull. U. S. Fish. Comm., **20**, pt. 2, 60, 1900 (1901); H. A. E., **10**, 173, 1904.

Fig. 126. *Epialtus bituberculatus*, natural size (after Milne Edwards).

Characters.—Carapace subpentagonal, with two tubercles on gastric region and two lateral teeth or lobes very variable in shape and relative size. In the typical form the lobes are separated by a shallow sinus, the carapace is distinctly wider at the posterior lobe; the rostrum is triangular, obtuse, and entire. In the varieties the width at the hepatic region may equal that at the branchial region, the anterior lobe is much more prominent, and may be either broad and obtuse or narrow and spiniform. Sometimes one lobe or both has a tubercle on its anterior margin. The rostrum varies in length and shape, and may be either triangular or oblong, entire or emarginate, sometimes constricted near the base. In the typical form the preocular teeth are obsolete but are present though small in some of the varieties; postocular tooth wanting. Abdomen of male with fourth and fifth segments fused. Chelipeds variable; hand in typical form wide, of moderate length, widening slightly toward distal end; movable finger with a tooth near its base; in the varietal forms the hand may be cristate, widening rapidly toward the fingers.

Dimensions.—Types: length from 6.4 to 8.5 mm.

Type Locality.—Coast of Chile.

Distribution.—Southern California (either Catalina Harbor or Monterey) to Chile; Indian River, Florida, to Rio de Janeiro; Bermudas (Rathbun). A specimen has also been collected at Laguna Beach, California, by W. A. Hilton.

Remarks.—Should be readily recognizable by its small size, as compared with *E. productus,* and by its entire rostrum.

Genus **Mimulus** Stimpson

Carapace flattened, smooth or nearly so, more or less pentagonal; lateral portions laminate, much produced, wing-like, anterolateral margin cut by a narrow fissure into two closely approximate lobes. Rostrum short, bifid, horizontal. Basal antennal joint enlarged at base and narrowing distally. Orbits incomplete below, but furnished above with a preocular and postocular spine. First pair of ambulatory legs exceeding others.

Mimulus foliatus Stimpson

Mimulus foliatus Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 200, pl. 3, fig. 1, 1860 (1862); A. Milne Edwards, Crust. Rég. Mex., pt. 5, p. 145, pl. 18, fig. 4, 1879; Holmes, Occas. Papers Calif. Acad. Sci., 7, 23, 1900; Rathbun, H. A. E., 10, 173, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 30, pl. 4, figs. 12–13, 1910.

a *b*

Fig. 127. *Mimulus foliatus,* ♂; *a,* dorsal view, × about 1⅓; *b,* ventral view of anterior portion, × about 2 (after Milne Edwards).

Characters.—Carapace flattened and marked with several undulations; lateral expansions a little reflexed, margin behind incision nearly twice the length of that in front; anterolateral and posterolateral angles wide, latter somewhat produced; median region tumid, and bearing two small obsolescent tubercles, in front of which there may be two rows of curved setae; posterior part of branchial region also with an obsolescent tubercle. Rostral horns short, flattened, with convex outer margins, the notch between them narrowly triangular and setose; on upper side of rostrum there are two double rows of curved setae. Preocular tooth large, triangular, acute; postocular small and pointing obliquely downward, separated by a fissure from preocular. Chelipeds of male large; hand oblong, fingers bent downward and curved inward, somewhat gaping near base, distally dentate;

chelipeds of females and young males relatively smaller; fingers contiguous and dentate along entire inner margin. Abdomen of female elliptical, seven-jointed, counting telson; of male, widest at third segment, narrowing rapidly to fifth which is about equal to sixth, telson narrow and longer than preceding joint.

Dimensions.—Type, male: length of carapace 27.9 mm., width 33.8 mm.; of specimen examined by Holmes, length of carapace 30 mm., greater width 32 mm.

Color.—A dull purplish tone, the legs crossed by light bands (Holmes). The young and even mature (egg-bearing) individuals show considerable variation in color, being in general tan or light reddish with the lateral expansions and marks on the cardiac region lighter in some cases, almost white. One specimen had the entire surface of the carapace, except the rostrum, the abdomen and the chelipeds clear white, while the remainder of the legs and rostrum were bright red. The legs in the majority show more or less distinct banding. The adults are often partially covered by a growth of bryozoa or sponges (Weymouth).

Type Locality.—Monterey, California, taken from the stomach of percoid fishes, "Cabesones."

Distribution.—From Unalaska, Alaska, to Mazatlan, Mexico (Rathbun).

Genus **Pugettia** Dana

Carapace with upper surface furnished with spines or tubercles; margins behind eyes produced into an alate expansion, behind which it is somewhat constricted. Rostrum two-spined. Basal antennal joint enlarged at base and narrowing distally; flagellum of antennae not entirely covered by the rostrum. Preocular spine present, large.

Key to the California Species of Pugettia

I. Postorbital projection a triangular tooth.

A. Hepatic expansion very wide (postocular spine and first anterolateral tooth united by a leaf-like expansion of the carapace). Merus of chelipeds with a prominent, irregularly dentate carina on the upper side, carpus cristate. Ambulatory legs with merus and propodus more or less carinated above. Ischium of maxillipeds with a longitudinal groove, exognath also grooved.

gracilis, p. 206.

B. Hepatic expansion narrow, transverse (postocular spine and first anterolateral tooth acute and distinct). Merus of chelipeds bears a few tubercles on the upper side but no carina; the inner side may become strongly ridged in adult males, but it is generally rounded in young males and females, the carpus has two or three carinae, which become more or less prominent in old males. Ambulatory legs with merus and propodus not crested. Surface of ischium of maxillipeds plane, but sometimes bearing a trace of a longitudinal groove, exognath not grooved.

richii, p. 207.

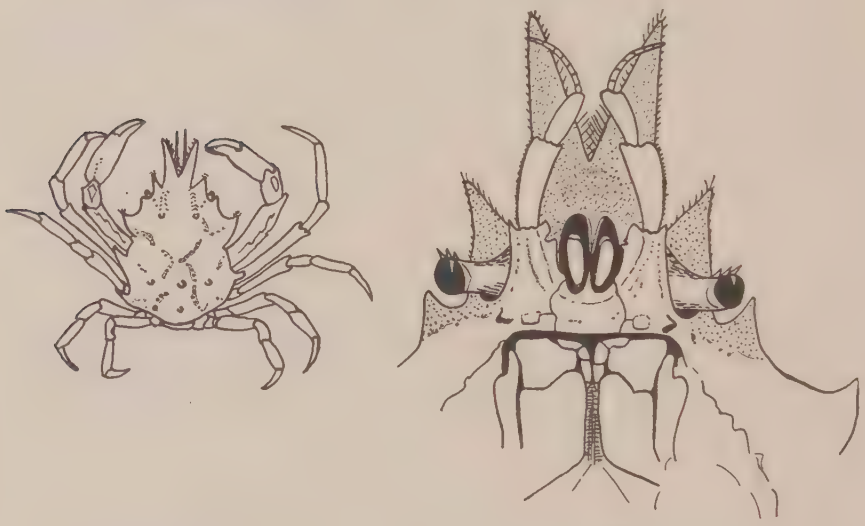
II. Postorbital projection an obtuse lobe. Merus of chelipeds with an irregular carina on the upper and inner margins, carpus strongly carinated on the inner and upper margins, and irregularly ridged on outer side. Ambulatory legs with joints not carinated. Ischium of maxillipeds grooved. (Not known north of San Pedro.)

dalli, p. 208.

Pugettia gracilis Dana

Plate 33, figure 7

Pugettia gracilis Dana, Amer. Jour. Sci. (2), **11**, 268, 1851; Crust. U. S. Expl. Exped., **1**, 117, 1852, pl. 4, fig. 3, 1855; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 25, 1900; Rathbun, H. A. E., **10**, 173, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 29, pl. 4, fig. 10, 1910; Way, Puget Sd. Mar. Sta. Publ., **1**, 370, fig. 21, 1917.



a *b*

Fig. 128. *Pugettia gracilis*, ♂; *a*, dorsal view, × 4/5; *b*, ventral view of anterior portion, × 3⅕ (after Dana).

Characters.—Carapace lyrate to broadly ovate, tuberculated; number and position of tubercles similar to *P. richii*, except middle anterior tubercle is small and sometimes obsolete, and cardiac tubercle may become scarcely visible in old specimens. Rostrum less prominent than in *P. richii*. Preocular tooth quite broad, postocular tooth triangular, acute, and pointing more nearly forward than in *P. richii*. Hepatic expansion very wide, postocular spine and first anterolateral tooth united by a leaf-like expansion of the carapace; posterior margin of first anterolateral tooth nearly longitudinal. Posterolateral tubercle smaller than in *P. richii*. Ischium of maxillipeds with a longitudinal groove; exognath also grooved. Merus of chelipeds with a prominent, irregularly dentate carina on upper side; carpus cristate.

Dimensions.—Type, female: 33.9 mm., width across from tip to tip of lateral spines 23.9 mm.

Color.—Of dorsal surface usually greenish brown, and of ventral side much lighter; but specimens found among red algae are a brilliant red (Way).

Type Locality.—Puget Sound.

Distribution.—From Aleutian Islands to southern California, low tide to 40 fathoms (Rathbun).

Remarks.—In the figure given above, the left side of the carapace shows posteriorly an abnormal occurrence of a second spine.

Pugettia richii Dana

Plate 33, figure 6

Pugettia richii Dana, Amer. Jour. Sci. (2), **11**, 268, 1851; Crust. U. S. Expl. Exped., **1**, 118, 1852, pl. 4, fig. 4, 1855; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 24, 1900; Rathbun, H. A. E., **10**, 173, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 30, pl. 4, fig. 11, 1910.

Fig. 129. *Pugettia richii*, ♂, dorsal view of carapace and chelipeds, × ⅘ (after Dana).

Characters.—Carapace ovate, tuberculated; median region tumid and furnished with four tubercles, the three anterior of which are nearly abreast (median one a little in advance of the others); two double rows of curved setae in front of lateral tubercles, and two similar rows on the rostrum; cardiac and intestinal regions each with a tubercle; two tubercles on branchial region, one before the other. Rostrum prominent, horns divaricate and convex above, triangular notch between them hairy. Preocular tooth acuté and directed forward, outward and upward; postocular acute and triangular. Hepatic expansion of carapace narrow, transverse, postocular and first anterolateral tooth acute and distinct; at posterolateral angle of carapace there is a prominent pointed tubercle. Surface of ischium of maxillipeds plane, but sometimes bearing a trace of a longitudinal groove; exognath not grooved. Chelipeds large in adult males, much shorter and more slender in females; the merus bears a few tubercles on the upper side but no carina, but it is generally rounded in young males and females; the carpus has two or three carinae which become more or less prominent in old males; hands compressed, upper edge acute; fingers shorter than the palm, and gaping at the base in old males.

Dimensions.—Type, male: length of carapace 48.7 mm., width between tips of teeth across gastric region 32.6 mm., width between tips of teeth across cardiac region 36 mm. Large male: from tip of rostrum to back of carapace 40 mm., width between the tips of the posterior teeth 30 mm. (25 mm. between their bases) (Weymouth).

Color.—In life red, varying from bright to dark, and often closely matching certain of the encrusting corallines (Weymouth).

Type Locality.—California.

Distribution.—British Columbia to San Diego, California, low tide (Rathbun).

Pugettia dalli Rathbun

Plate 33, figure 5

Pugettia dalli Rathbun, Proc. U. S. Nat. Mus., **16**, 232, 1893; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 26, 1900; Rathbun, H. A. E., **10**, 173, pl. 2, figs. 1, 1*a*, 1904.

Characters.—Carapace subtriangular, tuberculated; tubercles on gastric region much as in *P. richii* but anterior and posterior tubercles are small and obsolescent; a large tubercle on the cardiac region and one on the intestinal; branchial regions without areolations; there is an upturned spine on the posterolateral margin; on the hepatic region there is a slender transverse spine, curved slightly forward. Rostrum similar to that of *P. richii* but more slender, widely divergent. Preocular tooth acuminate; postocular tooth is thin, obtuse, its upper surface flattened and inclined downward at an angle of about forty-five degrees. Ischium of maxillipeds grooved. Chelipeds of male large; merus with an irregular carina on upper and lower margins; carpus strongly carinated on inner and upper margins and irregularly ridged on the outer side; hand large, wider than in *P. richii*, upper edge acute, fingers strongly gaping at base, meeting only at tips, a tooth on movable one near base; chelipeds of female smaller, hand narrower, fingers not gaping at base. Ambulatory legs much more slender than in specimens of *P. richii* of equal size.

Dimensions.—Type, male: length of carapace 11 mm., width without spines 6.5 mm., length of cheliped 13 mm., width of hand 3.3 mm.

Type Locality.—Southern California.

Distribution.—From San Pedro, California, to San Geronimo Island, Lower California; 6½ to 30 fathoms (Rathbun).

Remarks.—This species is much smaller than *P. richii*, which is found in the same localities, and it is at once distinguished from the latter by the hepatic region; in *P. richii* it is dilated in two flattened, horizontal spines, while in *P. dalli* it is furnished with one slender spine and a flattened obtuse oval tooth not horizontal (Rathbun).

Genus **Chorilia** Dana

Carapace pyriform, inflated, and spiny. Rostrum composed of two long, slender, straight, cylindrical spines, diverging from the base. Basal antennal joint large, furnished distally with a spine; flagellum usually exposed and visible from above at the sides of the rostrum. Preocular spine prominent, acute; postocular acute, deeply cupped on anterior face, and without hairs. Ambulatory legs elongated, subcylindrical, unarmed; first pair usually much the longest.

Chorilia longipes Dana

Chorilia longipes Dana, Amer. Jour. Sci. (2), **11**, 269, 1851; Crust. U. S. Expl. Exped., **1**, 91, 1852, pl. 1, fig. 5, 1855.

Hyastenus longipes Rathbun, Proc. U. S. Nat. Mus., **16**, 85, pl. 7, 1893.

Hyastenus (*Chorilia*) *longipes*, Holmes, Occas. Papers Calif. Acad. Sci., **7**, 33, 1900.

Chorilia longipes Rathbun, H. A. E., **10**, 174, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 33, pl. 6, fig. 16, 1910.

Fig. 130. *Chorilia longipes*, ♂, × nearly ½ (from Rathbun, U. S. N. M.).

Characters.—Carapace covered with sharp spines of unequal length. Rostrum long, spines nearly straight, pubescent, and divergent. Basal antennal joint armed at its external angle with a slender spine, with two smaller spines on margin behind it. Postocular spine points obliquely downward. Hands of chelipeds long, slender, compressed; palm subcarinated above, nearly smooth, and generally having a small tubercle on the outer side near the articulation; fingers long and slender. Legs and many parts of the body are covered with a short pubescence.

Dimensions.—Type, female: length of carapace 40.2 mm., greatest width 21.2 mm.

Type Locality.—Oregon.

Distribution.—From lat. 57° N, off Kadiak, Alaska, to lat. 32° N, off San Diego, California; 27 to 603 fathoms.

Genus **Chionoecetes** Krøyer

Carapace broad, depressed, more or less tuberculated or spinose. Rostrum short, flattened, notched, not depressed. Basal antennal joint very narrow, with a terminal spine; flagellum short. No preocular spine; postocular present; orbits shallow, open above so that the short, thick eye-peduncles are visible from above when retracted. Ambulatory legs more or less compressed.

Chionoecetes tanneri Rathbun

Chionoecetes tanneri Rathbun, Proc. U. S. Nat. Mus., **16**, 76, pl. 4, figs. 1–4, 1893; H. A. E., **10**, 174, 1904; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 40, 1900; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 35, pl. 7, fig. 19, 1910.

Fig. 131. *Chionoecetes tanneri*, ♂, × 3/16 (from Rathbun, U. S. N. M.).

Characters.—Carapace a little wider than long; much swollen at branchial regions, which are distended both vertically and laterally, concealing the lateral margin of the carapace; carapace covered with spines, the most conspicuous being arranged in irregular rows, one of which extends transversely across the anterior part of the gastric region; a second row extends from behind the orbits diagonally backward across the branchial region; a third from near inner angle of branchial region almost transversely to the outer margin, from which point a row of long spines extends forward along the lateral margin and is continued on the pterygostomian regions; this marginal row of long spines while forming the apparent lateral margin really overhangs and conceals the real margin. Small sharp spines border the orbits, the outer margin of the postocular teeth, and the inferolateral and posterior margins. Second segment of abdomen of male is bent downward at extremities in almost a right angle; there is a transverse ridge of spiny tubercles on the sternum in front of the abdomen; anterior to this ridge the sternum is deeply excavated.

Dimensions.—Type, male: length of carapace from base of rostral horns 119 mm., width without spines 130 mm.

Type Locality.—Gulf of the Farallones, California, 29 fathoms ("Albatross" station 3100).

Distribution.—From Bering Sea to off San Diego, California (lat. 32° 17′ N); 29 to 1625 fathoms (Rathbun).

Genus **Pelia** Bell

Carapace subpyriform. Rostrum composed of two divergent spines which are united at the base. Basal antennal joint elongated, its distal portion visible from above, at sides of rostrum; flagellum well developed. No preocular spine; postocular present; orbits small, with a superior and an inferior marginal hiatus, upper orbital margin smooth. First ambulatory legs much longer than the others.

KEY TO THE CALIFORNIA SPECIES OF PELIA

I. Male with fingers of chelae widely gaping; palm oblong, inflated; edges obtuse and subparallel.

tumida, p. 211.

II. Male with fingers of chelae meeting throughout the extent of their inner edges, except for a small narrow slit at the base; palm slender, more or less elongated, not inflated, only slightly enlarged, edges tapering distally.

clausa, p. 211.

Pelia tumida (Lockington)

Plate 34, figures 5 and 6

Pisoides (*?*) *tumidus* Lockington, Proc. Calif. Acad. Sci., **7**, 30, 67, 1877.
Pelia tumida Holmes, Occas. Papers Calif. Acad. Sci., **7**, 35, 1900.

Characters.—Carapace pyriform, rounded, tumid, covered with pubescence, but entirely devoid of spines; there is a small rounded tubercle on the summit of the gastric region, and a small rounded elevation on cardiac region; rostrum depressed, elongated, nearly one-half the length of the carapace, bifurcated for about half its length; horns narrow, diverging, and slightly upturned at the tip; no preorbital spine, postorbital small; basal antennal joint considerably longer than wide and devoid of teeth with the exception of one at the antero-external angle. Chelipeds unarmed; hand oblong, inflated, edges obtuse and parallel; fingers widely gaping.

Dimensions.—Type, male: length, 17 mm., width 11.4 mm.

Type Locality.—San Diego, California.

Distribution.—Santa Monica Bay, and Santa Catalina Island, California, to Magdalena Bay, Lower California.

Pelia clausa Rathbun

Plate 34, figures 1, 2, 3, and 4

Pelia pacifica Rathbun (not Milne Edwards), Proc. U. S. Nat. Mus., **16**, 90, 1893.
Pelia clausa Rathbun, Mem. Mus. Comp. Zool., **35**, 72, 1907.

Characters.—Very similar to *P. tumida*, with rostral horns slightly shorter, comparatively, and possibly a little more divergent, but differing markedly in the character of the hands of the male. In the males of *P. clausa* the fingers of the chelae meet throughout the extent of their inner edges, except for a small narrow slit at the base; the palm is slender and more or less elongated, only slightly enlarged, with edges tapering distally.

Dimensions.—Type, male: length of carapace 13.4 mm., width 8.5 mm.

Type Locality.—Southern California.

Distribution.—From Santa Monica Bay, California, to Magdalena Bay, Lower California (Rathbun).

Remarks.—The females of *P. clausa* are very similar to those of *P. tumida*. The differences are more comparative than apparent. In *P. clausa* the fingers and palm of the female are more slender, and the palm is less inflated.

Genus **Loxorhynchus** Stimpson

Carapace spiny or tuberculated. Rostrum two spined, spines coalescent at base and then divergent. Basal antennal joint enlarged, subquadrate, and having a laterally projecting spine at the outer angle. Preocular and postocular spines prominent; postocular flattened and densely hairy on anterior face, so that cornea of retracted eye is partially concealed from above; orbits interrupted by a deep sinus above and below.

Key to the California Species of Loxorhynchus

I. Hepatic region with two large spines; carapace with numerous nearly equal tubercles; sparingly hairy or smooth in adult.
grandis, p. 212.

II. Hepatic region with one large spine; carapace with from nine to twelve prominent tubercles; covered with a short, thick, felt-like coat of hair.
crispatus, p. 213.

Loxorhynchus grandis Stimpson

Loxorhynchus grandis Stimpson, Proc. Boston Soc. Nat. Hist., **7**, 85, 1857; Jour. Boston Soc. Nat. Hist., **6**, 452, pl. 20, fig. 1, pl. 22, fig. 1, 1875; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 29, 1900; Rathbun, H. A. E., **10**, 175, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 31, pl. 5, fig. 14, 1910; Baker, Rep. Laguna Mar. Lab., **1**, 102, 1912.

a *b*

Fig. 132. *Loxorhynchus grandis*, ♀, × ½; *a*, ventral; *b*, lateral view of rostral region (after Stimpson).

Characters.—Carapace broadly ovate, with numerous nearly equal tubercles; sparingly hairy or smooth in the adult; hepatic region with two large spines. Rostrum much deflexed, curved almost in a direction at right angles with the horizontal axis of the body. Preocular spine large, often more or less double pointed.

Dimensions.—Type, female: length of carapace 141 mm., width 115.3 mm. A large specimen taken at San Diego measured 186.4 mm. in length and 148.6 mm. in width (Stimpson).

Color.—Color of exposed parts is reddish, inclining to roseate, becoming yellowish, white on the sides. Fingers white (Stimpson).

Type Locality.—Coast of California, near San Francisco.

Distribution.—From Point Reyes and the Farallon Islands to San Diego, California; 6½ to 68 fathoms.

Loxorhynchus crispatus Stimpson

Loxorhynchus crispatus Stimpson, Jour. Boston Soc. Hist., **6**, 453, pl. 22, figs. 2–4, 1875; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 30, 1900; Rathbun, H. A. E., **10**, 175, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 32, pl. 5, fig. 15, 1910.

a *b*

Fig. 133. *Loxorhynchus crispatus*, ♂, × ½; *a*, dorsal; *b*, lateral view of rostral region (after Stimpson).

Characters.—Carapace rather narrowly triangular, not nearly so wide or inflated as in *L. grandis;* covered with a short, thick felt-like coat of hair; with nine to twelve prominent tubercles; hepatic region with one large spine. Rostrum but slightly depressed as compared with *L. grandis* and with more divergent horns.

Dimensions.—Type, male: length of carapace 87.6 mm., greatest width 57.4 mm. The carapace of a single specimen brought in from Point Reyes was 57 mm. in length.

Color.—Beneath the pubescence bluish white, the rostrum, spines, and feet being of a bright carmine hue (Stimpson). In alcohol the color ranges from reddish brown to tan; the carapace after removal of the hair often shows red markings, especially about the tubercles (Weymouth).

Type Locality.—San Miguel Island, California.

Distribution.—From Point Reyes and the Farallon Islands to San Diego, California; 4 to 53 fathoms.

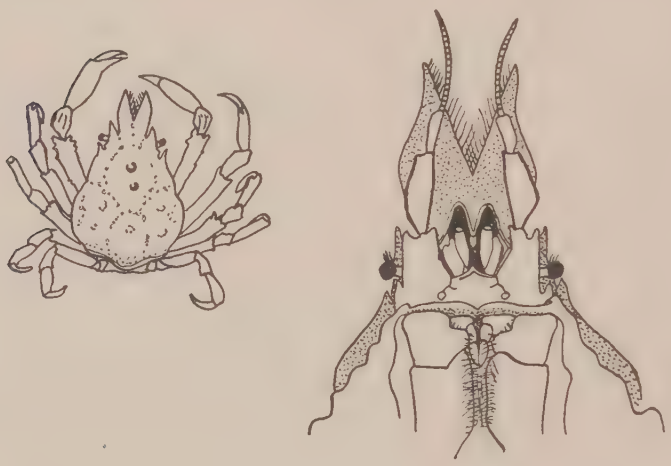
Remarks.—These crabs are generally found so thickly covered with foreign growth, such as hydroids, seaweeds, bryozoans and sponges, that in their natural environment they are scarcely recognizable as crabs at all (Holmes).

Genus **Scyra** Dana

Carapace subpyriform, tuberculated, but not spinose. Rostrum composed of two short, flattened horns. Basal antennal joint deeply concave, with outer margin flattened and produced but not spiny; next two joints flattened, with thin, broad lateral expansions. Preocular spine present, acute; postocular deeply cupped on anterior face and without hairs; orbits small, deep, with a fissure above and below, the lower and sometimes the upper being open.

Scyra acutifrons Dana

Scyra acutifrons Dana, Amer. Jour. Sci. (2), **11**, 269, 1861; Crust. U. S. Expl. Exped., **1**, 95, 1852, pl. 2, fig. 2, 1855; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 41, 1900; Rathbun, H. A. E., **10**, 175, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 33, pl. 6, fig. 17, 1910; Way, Puget Sd. Mar. Sta. Publ., **1**, 371, fig. 27, 1917.



a *b*

Fig. 134. *Scyra acutifrons*, ♂; *a*, dorsal view, × 4/5; *b*, ventral view of anterior portion, × 3 1/5 (after Dana).

Characters.—Carapace furnished with rounded tubercles; gastric region with an acute tubercle near the center, behind which is a larger and more obtuse tubercle; branchial regions bearing a large projecting tubercle, in front of which is an elevated prominence, which may bear several small tubercles though often it is quite smooth; cardiac region with a large tubercle; a smaller one on the intestinal region. Rostrum short, horns ovate-lanceolate, about one-quarter the length of the carapace. Chelipeds of male large, hand long, narrow, compressed, palm below the wide carina often inflated; fingers deflexed and in old males gaping at base, in which case there is generally a large tooth near the base of the movable finger.

Dimensions.—Type, male: length of carapace 27.5 mm., width 18 mm.

Color.—Dull, usually gray or tan with more or less red on chelipeds and walking legs; usually so encrusted with bryozoans that it is difficult to see the color. Like other spider crabs, they are usually covered with a variety of decorative materials. Sponges, hydroids, and bryozoans are used by them more than algae (Way).

Type Locality.—Oregon.

Distribution.—From Kadiak, Alaska, to San Diego, California. Low tide to 40 fathoms (Rathbun).

Remarks.—The individuals of this species vary considerably with age. In old males the tubercles on the carapace are rougher and more prominent, the posterior tubercle on the branchial region projecting over the sides of the carapace; the horns of the rostrum become widened at the base; the chelipeds are

much larger. In the female the tubercles on the carapace are smoother; those on the gastric region being small or obsolescent (Holmes). Regarding spine-like processes on basal antennal joint of figure given above and mentioned in the description given by Holmes, in his paper cited in synonymy above, Weymouth says, "The anterior external angle of the basal antennal joint is somewhat produced but seems hardly to form a spine as stated by Holmes. The 'two spines or teeth on the outer margin' behind this are seldom prominent, the anterior being a little more than an undulation of the margin." "Like most of the spider crabs this species is generally so overgrown with sponges and other forms as to conceal the color."

Genus **Herbstia** Milne Edwards

Carapace broadly triangular, subpyriform or ovate, tuberculated or spinose. Rostrum short, composed of two short flattened, acute horns, somewhat dilated at the base. Basal antennal joint narrowing distally, outer margin not produced, spiny, distal portion not entirely covered by the rostrum. Merus of ambulatory legs spinose. With or without preocular spines; postocular present; deeply cupped on anterior face and without hairs; orbits shallow.

Herbstia parvifrons Randall

Herbstia parvifrons Randall, Jour. Acad. Nat. Sci. Phila., 7, 170, 1839; Holmes, Occas. Papers Calif. Acad. Sci., 7, 38, 1900.

Herbstia (Herbstiella) camptacantha A. Milne Edwards, Crust. Rég. Mex., 78, pl. 18, fig. 3, 1879; Holmes, Occas. Papers Calif. Acad. Sci., 7, 37, 1900.

Rhodia parvifrons Rathbun, H. A. E., 10, 175, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 34, pl. 7, fig. 18, 1910.

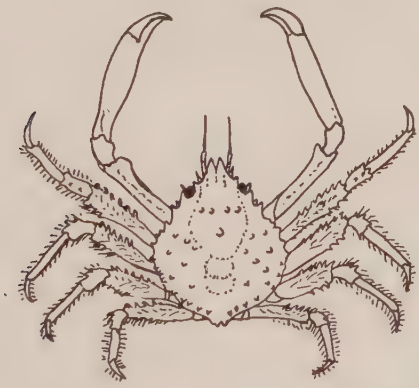


Fig. 135. *Herbstia parvifrons*, ♂, × about 1¼ (after Milne Edwards).

Characters.—Carapace ovate, punctate, flattened above, armed with several small tubercles and somewhat hairy; gastric region in front with four, at times inconspicuous tubercles in a transverse row, a median rounded tubercle on the posterior portion of the gastric region; three or four small tubercles on the cardiac region, and about five on each branchial region; two tubercles in a transverse line, on the intestinal area. Rostral horns very short, one-ninth to one-tenth the length

of the carapace. Spine at antero-external angle of basal antennal joint prominent; on margin behind it there are two spines, posterior of which is sometimes reduced to a small blunt tooth. Preocular spine present acute; there is a small spine or tooth on margin of orbit above postocular tooth, while below it there is a spine on the inferior orbital margin; beside postocular tooth anterolateral margin is furnished with about five spines, and there are several smaller ones on the postero-lateral margin.

Dimensions.—Type: length of carapace scarcely 25.4 mm.

Color.—Carapace is light tan mottled with dark brown; the ambulatory legs are banded with reddish brown and the chelipeds, with the exception of the light tips of the fingers, are a still more pronounced red, usually covered with sponges of various kinds and the like (Weymouth).

Type Locality.—Western America.

Distribution.—From Monterey Bay, California, to Acapulco, Mexico; low tide to 40 fathoms.

Remarks.—Miss Rathbun has called my attention to the fact that the genus *Herbstia* is not invalidated by *Herbstium* of Leach, 1823, hence its restoration above.

Superfamily Brachyrhyncha

Key to the California Families of the Brachyrhyncha

I. Carapace usually round or transversely oval, circular rather than square; squarish in the Goneplacidae. Frontal region not markedly broad, generally produced horizontally in lobes or teeth. Frontal and lateral margins produced into spines, or teeth. Palp of third maxillipeds articulates at or near antero-internal angle of merus. Male genital openings coxal.

A. Legs flattened and more or less distinctly adapted for swimming. Antennules fold back transversely or obliquely. Front with or without median tooth. Outer maxillipeds not overlapping endostome. (Only one specimen ever reported north of Santa Monica Bay.)

B. Legs not adapted for swimming.

Portunidae, p. 236.

1. Antennules fold back longitudinally. Front with several teeth, one of which is median. Outer maxillipeds overlapping endostome.

a. Carapace subcircular; antennal flagella long and hairy. (Known only from northern California.)

Atelecyclidae, p. 234.

b. Carapace broadly oval; antennal flagella usually short, more or less hairy.

Cancridae, p. 217.

2. Antennules fold back transversely or obliquely. Front generally divided by a median notch.

a. Carapace more or less transversely oval. Fingers of chelipeds more or less curved. Fronto-orbital border not equalling width of carapace.

Xanthidae, p. 238.

b. Carapace squarish. Fingers of chelipeds practically straight longitudinally. Fronto-orbital border nearly equalling width of carapace. (Not known north of San Pedro.)

Goneplacidae, p. 248.

II. Carapace usually square or squarish, more or less quadrilateral in outline, lateral margins nearly parallel. Frontal region usually broad, bent downward, usually without teeth or sharp lobes. Palp of third maxillipeds does not articulate at or near the inner angle of the merus. Position of male genital openings peculiar since they lie upon the sternum and are connected with the copulatory appendages on the abdomen by means of furrows excavated in the sternum.

A. Small commensal or symbiotic crabs with front, orbits and eye-stalks usually very small. Carapace often more or less membranaceous, frequently more or less rounded.

Pinnotheridae, p. 249.

B. Free-living crabs, with front, orbits, and eye-stalks not especially reduced. Carapace hard and firm, lateral margins either strictly parallel or only slightly arched.

1. Third maxillipeds with more or less of a gap left between them. Front usually markedly wide, eye-stalks of moderate size. Dactyls of ambulatory legs compressed, and armed with strong spines. The base of the abdomen in the male usually covers the whole width of the last thoracic sternum.

Grapsidae, p. 269.

2. Third maxillipeds almost or quite close to the mouth. Front moderately or very narrow; orbits transversely lengthened, eye-stalks usually very long. Dactyls of ambulatory legs styliform and devoid of spines. The base of the abdomen usually does not cover the whole width of the last thoracic sternum between the last pair of legs.

Ocypodidae, p. 277.

Family Cancridae

Carapace broadly oval, front with several teeth, one of which is median. Antennules fold back longitudinally. Antennal flagella usually short and more or less hairy. Third maxillipeds overlapping endostome.

Genus **Cancer** Linnaeus

Carapace transverse, subelliptical, often indistinctly areolated; front narrow, cut into five teeth or lobes. Eye-stalks short; orbits small, with two fissures in both upper and lower margins. Basal antennal joint usually somewhat enlarged and united with the front, thus excluding the flagellum from the orbit.

Key to the California Species of Cancer

(For key to the California specimens of Cancer 20 mm. and less in width see p. 219)

I. Anterolateral and posterolateral margins meeting at a distinct angle; carapace widest at ninth or tenth (sometimes eighth) tooth; nine, ten or eleven teeth.

A. Front markedly produced beyond outer orbital angles, forming five subequal teeth. Fingers of chelipeds dark-tipped.

productus, p. 220.

B. Front not markedly produced beyond outer orbital angles, formed of five unequal teeth; outer teeth larger and more widely separated from the three median teeth than these are from each other.

1. Carapace widest at tenth anterolateral tooth; posterolateral margin behind it entire, without teeth; anterolateral teeth with more or less prominent serrations anteriorly. Fingers of chelipeds without dark color.

magister, p. 229.

2. Carapace widest at ninth (sometimes eighth) anterolateral tooth; always with at least a rudimentary tenth and sometimes an eleventh tooth behind it on the posterolateral margin.

a. Anterolateral teeth low, projecting less than one-third the length of base, not spiny-pointed. Fingers of chelipeds without dark color. Merus of outer maxillipeds elongated, rounded anteriorly. (These characters, except those of the fingers of the chelipeds, do not hold in very small specimens, for which see key on p. 219.)

gracilis, p. 232.

b. Anterolateral teeth not low, projecting more than one-third the length of base, often spiny-pointed. Fingers of chelipeds dark-tipped. Merus of outer maxillipeds not elongated, truncated anteriorly.

i. Carpus of cheliped with two spines, one above at distal end and a second below this on inner angle; hand roughened and armed above with two or more spines, sometimes inconspicuous.

a. Anterolateral teeth acute, strongly produced, alternately large and small; carapace pubescent.

i. Tenth anterolateral tooth conspicuous, eleventh present; dactyl of cheliped spiny. Carapace strongly areolated.

gibbosulus, p. 226.

ii. Tenth anterolateral tooth inconspicuous, eleventh not present; dactyl of cheliped not spiny. Carapace slightly areolated. (Not known north of Half Moon Bay.)

jordani, p. 228.

b. Anterolateral teeth broadly triangular, not strongly produced, subequal. Carapace strongly areolated, not pubescent. (Not known north of San Diego.)

amphioetus, p. 223.

ii. Carpus of cheliped with a single spine above at distal end; hand smooth or granulated, without spines.

a. Carapace widest at eighth anterolateral tooth, eleventh distinct; under parts spotted or blotched with reddish.

antennarius, p. 224.

b. Carapace widest at ninth anterolateral tooth, tenth inconspicuous; under parts of uniform light color. (Not known north of Long Beach.)

anthonyi, p. 227.

II. Anterolateral and posterolateral margins not meeting at a distinct angle; carapace widest at seventh or eighth tooth; twelve or thirteen teeth. Dark color on dactyls of chelipeds reaching more than half the length of the outer margins, movable finger almost entirely dark colored. Merus of outer maxillipeds with antero-external angle produced.

oregonensis, p. 234.

KEY TO THE CALIFORNIA SPECIMENS OF CANCER, 20 MM. AND LESS IN WIDTH

I. Front markedly produced, formed of five subequal teeth, of which the median is the most advanced; anterolateral teeth never spiny-pointed; carapace never pubescent. Fingers of chelipeds with dark color. Color pattern of carapace extremely variable, from more or less uniform color to prominent longitudinal lines.

productus, p. 220.

II. Front not markedly produced, formed of five unequal teeth, the outer teeth larger and more widely separated from the three median teeth than these from each other.

A. Carapace widest at ninth or tenth anterolateral tooth.

1. Carapace widest at tenth anterolateral tooth, which is always the last; posterolateral margin unbroken, entire. Carpus of cheliped with a single spine above, at distal angle; hand light colored, fingers without dark color.

magister, p. 229.

2. Carapace widest at ninth anterolateral tooth.

a. Tenth anterolateral tooth (counting that next to the eye as one) prominent.

i. Tenth anterolateral tooth usually spiny-pointed, never broadly rounded; rarely an eleventh tooth.

a. Carpus of cheliped with two prominent spines (not counting that at hinge), one above, at distal end, and the second below it, at inner angle.

i. Tenth anterolateral tooth projecting laterally beyond carapace as seen from above; carapace comparatively smooth, without pubescence. Hand of cheliped light colored; fingers without dark color.

gracilis, p. 232.

ii. Tenth anterolateral tooth projecting dorsally, not reaching beyond outline of carapace as seen from above; carapace hairy, markedly areolated, granulated, granules in scattered groups. Hand of cheliped light colored; fingers with blotch of dark color, extreme tips light colored.

gibbosulus, p. 226.

b. Carpus of cheliped with a prominent spine above, at distal end; below this, at inner angle, an inconspicuous spine sometimes present. Carapace granulated, granules crowded. Hand of cheliped light colored, fingers with blotch of dark color, extreme tips light colored.

antennarius, p. 224.

ii. Tenth anterolateral tooth broadly rounded, never spiniform, an eleventh tooth invariably present; carapace prominently areolated, tending to become tuberculated, not hairy; teeth blunt, lamellate. Palm of cheliped with double row of tubercles on upper edge, and fingers almost wholly dark colored, much as in *C. oregonensis*. (Not known north of San Diego.)

amphioetus, p. 223.

b. Tenth anterolateral tooth absent or represented by a rudiment.

i. Carapace finely pubescent; anterolateral teeth alternately large and small, more or less narrowly triangular, spiny-pointed. Carpus of cheliped with two spines, one above at distal end, and a second less conspicuous spine below this, at inner angle; hand dark colored, fingers darker than palm, extreme tips light colored. (Not known north of Half Moon Bay.)

jordani, p. 228.

ii. Carapace smooth or sparsely and coarsely pubescent; anterolateral teeth alternately large and small only in very young specimens (5 mm. or less); teeth broadly triangular becoming quite blunt anteriorly. Carpus of cheliped with a spine above at distal end and only in very young a second minute spine below this at inner angle. (Not known north of Long Beach.)

anthonyi, p. 227.

B. Carapace widest at seventh or eighth anterolateral tooth; anterolateral and posterolateral margins not meeting at a distinct angle; marginal teeth tending to become blunt, lamellate with age. Carapace well areolated and more or less tuberculated, usually strongly so. In larger specimens the carpus is armed much as in *C. antennarius* above; in smaller specimens tubercles supplant the spines; upper edge of palm with a double row of blunt tubercles, fingers almost wholly dark colored.

oregonensis, p. 234.

Cancer productus Randall

Cancer productus Randall, Jour. Acad. Nat. Sci. Phila., **8**, 116, 1839; Dana, Crust. U. S. Expl. Exped., **1**, 156, 1852; pl. 7, fig. 3, 1855; Lockington, Proc. Calif. Acad. Sci., **7**, 94, 1877; Rathbun, R., The Fisheries and Fishery Industries of the U. S., sec. 1, 771, pl. 262, 1884; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 47, 1900; Rathbun, H. A. E., **10**, 175, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 40, pl. 8, figs. 20–24, 1910.

Characters.—Front markedly produced beyond outer orbital angles, forming five subequal, generally obtuse teeth which lie in the same horizontal plane, outermost pair not more widely separated from inner pair than these are from median tooth; fronto-orbital width about one-fifth width of carapace. External orbital tooth small, next behind it rounded, succeeding teeth becoming larger and more acute posteriorly, the last tooth in adult specimens being the largest; between the teeth margin of carapace is marked with short, closed fissures. Carpus of chelipeds with a large tooth at the antero-internal angle and a smaller one behind

the upper hinge joint; dark color on dactyls of chelipeds reaching less than one-half the length of the outer margin.

Dimensions.—Type, length hardly 25.4 mm., "but probably attains a greater size" (Randall). A series of twenty-eight mature males and females measured by Weymouth ranged from 24.5 mm. to 173.5 mm. in width.

Color.—The prevailing color of the adult is red, becoming darker and more brownish above, and orange or yellowish below. Among four young ones found under the stones at Monterey, two are chocolate color, with a somewhat darker tint on the elevated parts of the carapace; one is bright yellow, with irregular blotches of red; and the fourth is yellow with narrow red stripes, giving it a zebra-like

Fig. 136. *Cancer productus,* × about ½ (after R. Rathbun).

appearance. An examination of young and adult specimens only would lead to the belief that they were distinct species, but a full series of specimens, of all sizes and ages, reveals their specific identity (Lockington).

Weymouth describes the coloration as follows:

The adult color of a dark red above, below a dirty white or yellowish white is not invariable, though there are no striking differences; some adults show a light red above due to minute red spots, not so numerous as in the case of the darker color on a yellowish ground. The longitudinal colored lines of the immature specimens as described by Holmes is not the invariable youthful coloration; various mottled patterns are also found and occasionally the red of the adult.

Type Locality.—Western America.

Distribution.—From Kadiak, Alaska, to Magdalena Bay, Lower California.

Remarks.—This species is common in the bay at San Francisco, but I have never found either it or its young beneath the stones on the beach, as is the case at Monterey. In April of this year [1876] half an hour's search under the stones at Preston's Point, Tomales Bay, procured me twelve fine adult specimens, all or most of them females. I did not observe any ova attached to them, and I thought it singular that on a second visit to the spot in July, I could not find a single specimen, though at low-tide mark I secured an overgrown male who had lost too many limbs to retreat with sufficient quickness (Lockington).

Biological Survey of San Francisco Bay.—Cancer productus, the "red crab," like *Cancer antennarius* is quite closely confined to the middle bay and principally that portion lying west of Alcatraz, Angel Island, and the head of Raccoon Strait. Only four of the thirteen middle bay stations at which this species was taken lie east of this line. There is no record of it from either the upper bay or outside and only three (D 5723, 5767, 5802) from the lower bay, near its extreme upper end between Alameda and the Mission Rock (see plate 5).

An analysis of the various bottoms on which this species was taken seems to offer a very striking explanation of its limited distribution within the bay, in view of the fact that *Cancer productus* lacks the so-called "straining apparatus" for removing fine particles of foreign matter from the inhalant respiratory stream of water and consequently is restricted to more or less hard, "rocky or gravelly bottoms." (Weymouth, 1914, p. 124.)

Twenty-four of the total thirty-four specimens taken in connection with the survey, inclusive of two seined at Sausalito, were obtained within the region outlined above. The bottom throughout its extent is more or less hard and is largely sand, gravel, and rock in varying proportions; at one station (D 5763) the bottom for the greater part was overgrown with eel-grass. Practically every *Cancer productus* was a small or juvenile, ranging from 11 to 29 mm. in width, and it is interesting to note that the only large specimen taken was dredged in this sand, gravel, and rock area, in 2 to 3 fathoms, from a rocky bottom consisting of angular stones of various sizes, off Yellow Bluff (D 5773) just south of Sausalito. Three small specimens of the same species were taken with it. Of the remaining four middle bay stations, two (D 5708, 5826) lie in the stretch between Point San Quentin and the Southampton Shoal light, with bottoms of "sandy mud" and "fairly clean sand, with very little mud and many shell fragments" respectively; one small individual was obtained at each station. One of the other two stations lies off the northeast shore of Angel Island (D 5718), where the bottom is "soft grey mud with great quantities of worm tubes and ophiurians"; and the second was dredged in a line (D 5754) across the mud flats, of slightly gritty brown mud, lying between the channel east of Angel Island and the Berkeley shore. From each of these stations but one small specimen was returned.

In the lower bay: six medium sized individuals were obtained in mid-channel off Mission Rock (D 5723) on a bottom of "black sticky mud streaked with brown," covered "with many shells, clinkers, and abundant ophiurians." Another specimen was taken at an adjacent station (D 5802) on a "sandy, shelly, mud" bottom; while still another was dredged on the edge of the "muddy sand" flats off Alameda (D 5767).

The highest temperature at which any particular specimen was taken, was 17.0° C, off Alameda (D 5767), the lowest, 11.0° C, east of Fort Point (D 5779); the greatest salinity was 33.3, off Sausalito (D 5801), the least 21.7, off Point San Quentin (D 5708).

One half of all the dredging records were in less than 9 fathoms; of the remainder only two exceeded 19 fathoms, the deeper of which was made in Golden Gate (D 5808) in 27 to 43 fathoms, at a time when the observed bottom temperature and salinity were 11.1° to 13.4° C and 32.3 to 32.4 respectively. Two specimens were seined at Sausalito in March, 1912.

A complete list of dredging stations at which this species was taken includes: D 5700, 5702, 5708, 5718, 5723, 5754, 5763, 5767, 5773, 5778, 5779, 5795, 5801, 5802, 5808, 5826.

Cancer amphioetus Rathbun

Plate 36, figures 1 and 2

Trichocarcinus dentatus Miers, Proc. Zool. Soc. London, 7, 34, 1879.
Cancer amphioetus Rathbun, Proc. U. S. Nat. Mus., 21, 582, 1898; H. A. E., 10, 175, pl. 6, fig. 3, 1904.

Characters.—Carapace smooth, not pubescent, but strongly areolated; antero-lateral margins with nine flat, broadly triangular, not strongly produced, subequal teeth; behind the ninth tooth is usually a small tooth on the posterolateral margin, which is defined by a line of granules; fronto-orbital width nearly one-half the width of the carapace; front five-toothed, the middle one very small, the two outer separated from the rest by a wide interval. Carpus with two spines, one above, at distal end, and a second below this, on inner angle; hand of cheliped with usually two spines on its upper margin and three longitudinal raised ridges on its outer surface; dark color on the fingers of the chelipeds reaching more than one-half the length of the outer margin, movable finger not more than two-thirds colored.

Dimensions.—Type, male: length 22.2 mm., width 25.4 mm.; female: length 27.5 mm., width 38.1 mm.

Type Locality.—Off the Korean coast.

Distribution.—From San Diego Bay, California, to the Gulf of California; Japan; Korea, 11½ and 169 fathoms (Rathbun).

Cancer antennarius Stimpson

Plate 35, figure 3; plate 36, figure 8

Cancer antennarius Stimpson, Proc. Calif. Acad. Sci., **1**, 96, 1856; Jour. Boston Soc. Nat. Hist., **6**, 466, 1857; Rathbun, R., The Fisheries and Fishery Industries of the U. S., sec. 1, p. 771, pl. 263, 1884; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 49, 1900; Rathbun, H. A. E., **10**, 176, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 47, pl. 10, fig. 31, pl. 11, fig. 32, 1910.

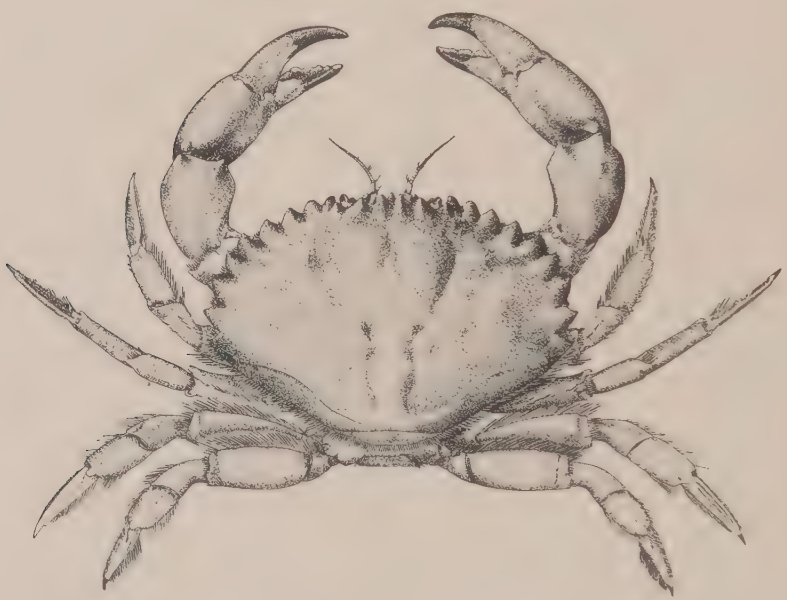


Fig. 137. *Cancer antennarius,* × about ½ (after R. Rathbun).

Characters.—Carapace smooth, widest at eighth anterolateral tooth, eleventh (really the second posterolateral) tooth distinct; fronto-orbital width one-third the width of the carapace; front not produced, the three median teeth separated from the outermost pair, which is the largest, middle tooth smaller and rather below the lateral ones. Merus of outer maxillipeds with distal margin nearly transverse, angles rounded. Carpus of chelipeds with a single spine above, at distal end; outer surface of hand costate, costae well marked in the young, almost obsolete in the adult; dark color on the fingers of the chelipeds, reaching more than one-half the length of the outer margins. Under parts spotted or blotched with reddish. Dactyls of ambulatory legs with eight longitudinal sulci, three superior, three inferior, one anterior, and one posterior.

Dimensions.—Types, male: length of carapace 61.7 mm., width 94 mm.; female: length of carapace 54.1 mm., width 78.2 mm. The Bay specimens ranged from 8 to 57 mm. in width.

Color.—Color of live specimens is fairly uniform and undergoes little change in alcohol. The general shade is a dark red, usually more or less mottled with a

lighter, more yellowish tinge; the under parts are yellowish white spotted with red, a coloration not found in any other species of *Cancer* examined (Weymouth).

Type Locality.—San Francisco Bay.

Distribution.—Queen Charlotte Sound, British Columbia, to Magdalena Bay, Lower California. Shallow water to 7 fathoms (Rathbun).

Remarks.—From Weymouth (1910, p. 47) I have taken the following:

There is considerable variation in this species and apparently a tendency toward two types, the extremes of which might readily be taken as a separate species. By far the greater number—which I would consider typical *C. antennarius*—have a smooth carapace devoid of hair except in the very young, 15 mm. and less in width which exhibit a few coarse hairs. A small number show a tendency toward hairiness and roughness of the hand, the extreme type of which is represented by a young female, measuring 46 by 50 mm. In this the whole carapace is densely pubescent (typical specimens of half the size show a perfectly bare carapace) and on the summits of the areolations, which are more marked than in the typical form, there are bunches of larger and stouter hairs. The granulations on these elevations are coarser than on the rest of the carapace, and in some cases pass into small spines. The anterolateral teeth do not differ markedly from the typical form except in being more thickened and in having the teeth spiny-pointed. The frontal teeth are more acute and thicker than is common in *C. antennarius*, especially those lying on either side of the median tooth, The tips of the basal joint and of the adjoining tooth on the lower orbital margin are more acute than in typical *C. antennarius* of the same size.

The chelipeds and ambulatory legs are pubescent, as is the case with the carapace. The carpus of the chelipeds is marked with several costae bearing low spines and rows of hairs; these costae are generally indicated in the typical form by a line of slightly coarser granulations. There is an acute tubercle above the hinge, a strong spine at the inner angle, and a well marked spine below this. These spines are present in some typical *C. antennarius* of the same size, but the lower spine is more generally lacking and never of as great size. The hand is marked with two superior and five external carinae, all formed of rows of hairs and spines, the spines in the upper carinae being much longer and more pronounced. In typical *C. antennarius* of the same size these carinae are more or less well marked by rows of granulations.

This specimen is, as I have said, the extreme of divergence from the typical form; other smaller individuals show the same pubescence, some have the same extreme type of areolation, notably a larger female from San Diego, the only one not from Monterey Bay here considered. Many young show roughness of the hand, but no other specimen combines as many of these characters.

The total of these variations from the typical form of *C. antennarius* might merit specific distinction were it not for certain other facts. All specimens in which I have noticed these characters in any marked degree are immature females. Though they differ from typical forms of the same size, and therefore presumably of similar age, certain of the characters, chiefly the roughness of the hand and the pubescence of the carapace, vary with age in the typical form, being more apparent in the young, so that these differences though apparently much greater than those due to age cannot be said to be of a dissimilar kind. Again, in the typical adult, the female has a more convex and deeply areolated carapace than the male, which raises the question whether the difference in this character may not be, in part, sexual.

Miss Rathbun has informed me that she has examined very hairy specimens of about the size described, 40 and 50 mm., from La Jolla and San Diego, which she considered as a variety of *C. antennarius*. Sufficient material may establish this variety, but the collection at hand does not seem to warrant it.

See also *Remarks* under *C. gibbosulus*.

Biological Survey of San Francisco Bay.—Cancer antennarius, the "rock crab," is only recorded from the middle bay and particularly from that section lying between Sausalito, Fort Point, and Point Bonita, or in the words of Stimpson (Proc. Calif. Acad. Sci., **1**, 88,

1856), "found on rocky bottoms in two or three fathoms about the mouth of the Bay of San Francisco." Of the ten specimens taken during the survey all but two are small or juvenile specimens. These two are large adult specimens and were both taken at Sausalito, one in the 150-foot seine and the other in a crab-net over the ship's side. Of the smaller specimens, one of about medium size (70 mm. wide) was collected along the Sausalito shore; a very small one (12 mm. wide) was obtained from among the rocks and algae between tide marks at Point Bonita, while another of like size (15 mm. wide) was dredged in a similar environment in 2¼ to 3½ fathoms (D 5778) on the south side of Golden Gate, inside of Fort Point; still two other juvenile specimens were dredged (D 5808, 5845) in 27 to 49 fathoms in the outer central portion of Golden Gate. The three remaining specimens, also juvenile (two averaging 35 mm., and one measuring 8 mm. in width), were taken in two hauls of the tow-net, off California City (H 5135) and Point San Quentin (H 5137), respectively, at a considerable distance from the restricted area in which all the other specimens were taken. These tow-net hauls show a maximum temperature of 18.2° C at the time they were made, which is considerably higher than the one given in the range of temperature of the hydrographic station (H 4967) to which all the other records of this species are referable (see page 354 and accompanying table). The range of temperature for this station is 8.7° to 14.3° C; its range of salinity, 26.6 to 33.3; a range not greatly at variance with the surface salinities (25.4 and 28.9) observed at the above hydrographic stations.

Cancer gibbosulus (De Haan)

Plate 36, figure 7

Corystes (*Trichocera*) *gibbosula* De Haan, Fauna Japonica, p. 45, pl. 2, fig. 4, pl. 13, fig. 3, 1835.

Cancer gibbosulus Rathbun, Proc. U. S. Nat. Mus., 21, 581, 1898; H. A. E., 10, 176, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 43, pl. 10, fig. 29, 1910.

Characters.—Carapace markedly areolated, sparsely pubescent, hairs rather coarse and harsh; anterolateral margin, including outer angle of orbit, with nine strongly produced and forward-curving teeth, all except first two tipped with spines, behind these on posterolateral margin a well marked tooth directed upward and not laterally, and a distinct spine representing the eleventh; fronto-orbital width one-third the width of the carapace; front with five more or less acute teeth (not counting the supraorbital), the three median of which are the smaller and are separated from the tooth at inner angle of eye by a distance greater than

that occupied by the three; supraorbital tooth more or less acute. Merus of outer maxillipeds abruptly truncated, inner angle slightly produced, inner margin with a conspicuous tooth below the articulation of palp. Chelipeds hairy; carpus with two spines, one above, at distal end, and a second below this, at inner angle; upper surface of hand with two rows of three to five spines, outer surface with five costae marked with hair and small spines; upper margin of movable finger spiny, dark color on fingers reaching less than one-half the length of their outer margins. Ambulatory legs hairy; dactyls slightly longer than propodi, straight, tipped with nearly straight, corneous spines.

Dimensions.—Type: length of carapace 21.2 mm., width 17 mm.; large male: 35.5 by 25.5 mm. (Weymouth). The specimens taken in connection with the Bay Survey measured from 11 to 29 mm. in width.

Color.—Whitish tone marked with irregular but symmetrically disposed reddish blotches, tips of fingers of chelipeds black, ambulatory legs light banded with red (Weymouth).

Type Locality.—Japan.

Distribution.—From Granite Cove, Port Althorp, Alaska, to San Geronimo Island, Lower California?, Japan. Shallow water to 40 fathoms.

Remarks.—Miss Rathbun tells me after a recent working over of the juvenile specimens of *Cancer* in the collection of the U. S. National Museum, that the inconspicuous spine sometimes present at the inner angle of the carpus of the cheliped of *C. antennarius* (cf. "key" on page 219) is occasionally so prominent as to lead one to confuse that species with *C. gibbosulus*, but that the character of the granulation of the carapace will serve to distinguish the two: the granules on the carapace of *C. antennarius* are crowded, while in *C. gibbosulus* they are not crowded but in scattered groups.

It also appears that there are no specimens of *C. gibbosulus* in the Museum collections from farther south than Santa Catalina Island.

Biological Survey of San Francisco Bay.—Only three specimens of *Cancer gibbosulus* were taken during the survey, outside, at station D 5790, 33 to 35 fathoms, bottom "very coarse variegated sand, with a small proportion of fine sand, temperature range 9.7° to 11.5° C, salinity 33.9.

Cancer anthonyi Rathbun

Plate 35, figure 1

Cancer anthonyi Rathbun, Proc. Biol. Soc. Wash., **11**, p. 111, 1897; Amer. Nat., **34**, 134, 1900; H. A. E., **10**, 176, pl. 6, fig. 2, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 49, pl. 11, fig. 33, 1910.

Characters.—Carapace widest at ninth anterolateral tooth; anterolateral teeth nine, broader and less projecting than in *C. antennarius*, margins denticulate, second to eighth tooth, inclusive, having the posterior margins about twice as long as the anterior, first to sixth tooth, inclusive, obtuse, last three teeth with short, sharp tips directed forward; tenth tooth (first posterolateral) indistinct, including it posterior margin shows only two very faint emarginations; front narrower than in *C. antennarius*. Merus of outer maxillipeds oblong, anterior margins slightly oblique. Carpus of chelipeds with a single spine above, at distal end; hand smooth

or granulated, without spines; dark color on fingers of chelipeds reaching less than half the length of the outer margins. Under parts uniform light color. Lower surface and legs less hairy than in *C. antennarius*. Dactyls of ambulatory legs with six longitudinal sulci, two superior, two inferior, one anterior, and one posterior.

Dimensions.—A male somewhat larger than the type measures 52.1 mm. long and 77.5 mm. wide (Rathbun).

Color.—Brownish red (Rathbun).

Type Locality.—Long Beach, California.

Distribution.—Long Beach, California, to Playa Maria Bay, Lower California.

Cancer jordani Rathbun

Plate 36, figures 5 and 6

Cancer jordani Rathbun, Amer. Nat., **34**, 133, 1900; H. A. E., **10**, 176, pl. 6, fig. 4, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 45, pl. 10, fig. 30, 1910.

Characters.—Carapace slightly areolated, hairy; anterolateral teeth separated to their bases, tips spiniform, second, fourth, sixth and eighth smaller than the others (outer orbital tooth being counted as the first); alternation in size of teeth varying with age, most noticeable in young specimens, less so in large ones, ninth tooth scarcely more prominent than eighth, tenth tooth (really posterolateral) indicated in older specimens and less conspicuously in younger ones by a slight gap in the small spines marking the posterolateral margin of the carapace; fronto-orbital width nearly one-half the width of the carapace. Merus of outer maxillipeds obliquely truncated, the inner angle the more advanced, corners rounded. Palms of the chelipeds have two superior and five external carinae, fringed with hair, superior carinae also with several spines; movable finger not spiny; extent of dark color on fingers of chelipeds variable.

Dimensions.—Type, female: length 15.5 mm., width 19.5 mm. (Rathbun). Large male: length 25.4 mm., width 33.4 mm. (Weymouth).

Type Locality.—Monterey Bay, California.

Distribution.—Pillar Point reef, Half Moon Bay, California, to San Geronimo Island, Lower California.

Remarks.—With regard to the relations of this species I have quoted the following from Miss Rathbun's Harriman Alaska Report (1904*a*, p. 177):

This species may have been confounded with the young of better known species. The young of *C. magister* has a nearly naked carapace, the ninth tooth of the lateral margin is produced sideways, the antennae are less than twice as wide as front, the merus of the maxillipeds is no broader than long, the carinae of the upper and outer surfaces of the hand are 6 instead of 7.

The carapace of young *C. antennarius* is also nearly naked (Dr. Holmes may have had in his hand *C. gibbosulus* when he described the carapace of young *C. antennarius* as thickly covered with hair); the teeth are all much thickened, the orbital teeth prominent, the two underneath being rounded, not sharp; the maxillipeds reach only to the base of the antennal segment, the merus not broader than long; the dark color on the fingers is more extensive than in *C. jordani*.

Cancer gibbosulus has a much more uneven carapace, strongly marked and rounded orbital teeth, a postero-lateral tooth, ninth tooth more prominent than eighth. Carapace hairy, as in *C. jordani*.

In *C. anthonyi* the antero-lateral teeth are low and broad, not alternately large and small, the first six having blunt angles; the inner supraorbital tooth is well developed.

Cancer magister Dana

Cancer magister Dana, Proc. Acad. Nat. Sci. Phila., **6**, 73, 1852; Crust. U. S. Expl. Exped., **1**, 151, 1852, pl. 7, fig. 1, 1855; Rathbun, R., The Fisheries of the U. S., sec. 1, 770, pl. 261, 1884; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 50, 1900; Rathbun, H. A. E., **10**, 177, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 42, pl. 9, fig. 25, 1910; Rept. British Columbia Comm. of Fisheries, 1914, 123–129, figs. 1–8; Calif. Fish and Game, **2**, no. 1, pp. 22–27, fig. 3, 1916.

Characters.—Carapace widest at tenth anterolateral tooth; posterolateral margin behind it entire, without teeth; anterolateral teeth with more or less prominent serrations anteriorly; front not produced, the three median teeth small, the middle one being slightly larger than the others and projecting farther forward; outermost pair larger than the others, not reaching so far forward, and separated from them by a considerable interval. Carpus of chelipeds with a single spine above, at distal end; fingers of chelipeds without dark color. Dactyls of ambulatory legs, especially those of last pair, much flattened.

Dimensions.—Type: length of carapace 120.7 mm., greatest width 177.8 mm.

Color.—Light reddish brown, darkest anteriorly, often light orange below; inner sides of the anterior feet and hands crimson (Stimpson).

Type Locality.—San Francisco Bay.

Distribution.—Unalaska to Magdalena Bay, Lower California. Low water to 50 fathoms (Rathbun).

Biological Survey of San Francisco Bay.—Cancer magister is quite universally distributed throughout the bay, upper, middle and lower, from Carquinez Strait to Point San Mateo (see plate 10), as well as outside. On the whole, so far as our survey records would seem to indicate, little discrimination is displayed by this species between the various kinds of bottom. In the upper bay where the bottom is predominantly muddy it was dredged at twelve (54%) of the stations. In the middle bay slightly more than half, eighteen (53%) of a total of thirty-four stations were in the eastern or muddy portion, the balance, sixteen (47%), being in the Raccoon Strait-Alcatraz-Golden Gate section with its sand, gravel and rock bottom. In the lower bay, however, where the bottom is possibly even more pronouncedly muddy than in the upper bay, only five (13%) of the hauls returned specimens, quite an evident falling off in the number of productive stations as compared with the other two divisions of the bay. Outside *Cancer magister* was obtained from six (35%) of the stations, all of which were made on a sandy bottom. Weymouth in his "Contributions to the Life-History of the Pacific Coast Edible Crab" (1914, p. 124) says:

Cancer magister shows a distinct preference for sandy bottoms. Occasionally it is found in the fine sand or mud of bays, but such are always recognizable by their discoloured appearance. It is found at times on gravel, but never, as far

as I know, on rocky shores. This preference for a sandy bottom is correlated with certain structural peculiarities and a group of habits which may be mentioned here on account of their bearing on the methods of fishing. Observation of the crab where accessible in shallow water and of the young in aquaria furnish the following facts: The crabs may often be seen moving quietly along over the

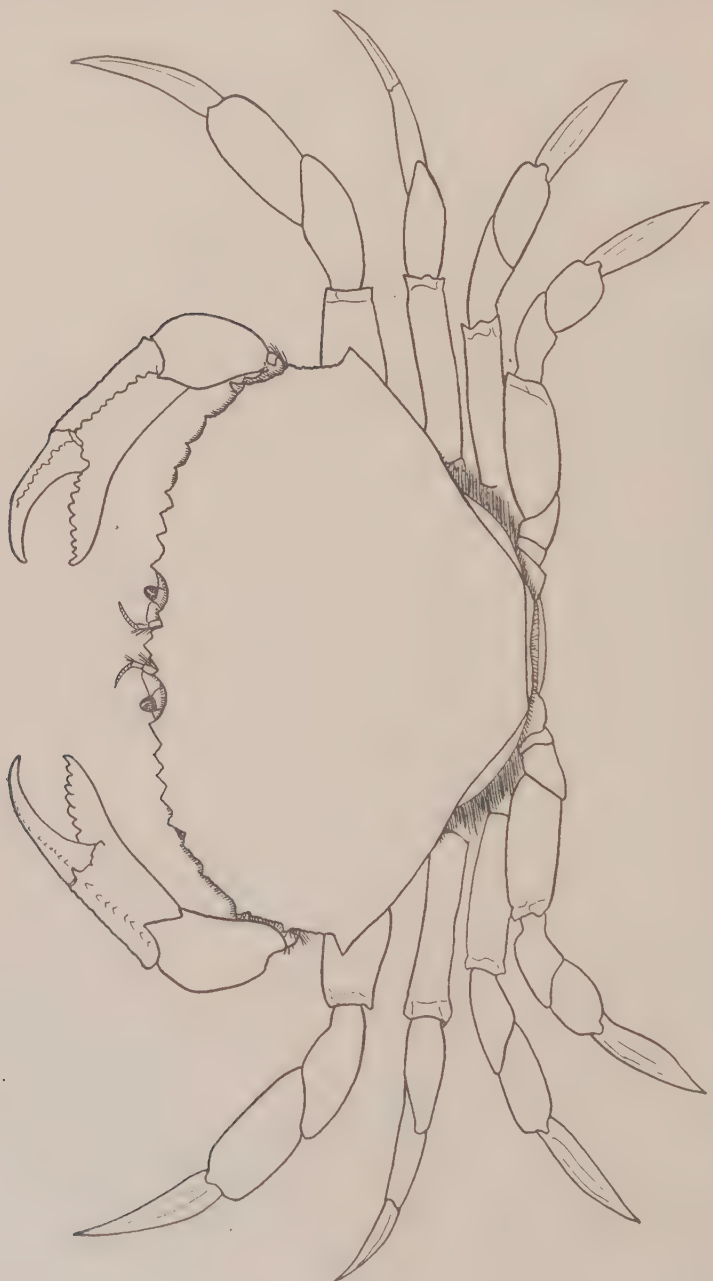


Fig. 138. *Cancer magister*, reduced (after R. Rathbun).

bottom; where buoyed up by the water they move lightly over the ground on the tips of their legs, presenting a striking contrast to their heavy and clumsy movements as ordinarily seen on land. If frightened they dart away with surprising speed. Some of the fish eaten by them must require much agility in their capture, though how this is accomplished is unknown. For the greater part of the time, however, they lie almost entirely buried in the sand, as may be seen from observation in the aquarium or in shallow bays. If examined at such a time, only the stalked eyes, antennules, and antennae will be visible, and below these a sort of chink between the anterior part of the shell and the flattened maxillipeds which are held slightly separated from the body. From this cleft issues a current, evident if the water is roily, or in the laboratory if India ink, for instance, be added.

When thus buried two conditions must be met: First and most important, a supply of fresh water for respiration must be obtained; and, second, the animal must be informed of the presence of food or enemies. Under ordinary conditions the water is forced through the gill-cavity by the rhythmic beating of a specialized appendage lying in an anterior prolongation of the chamber; the water is drawn in near the bases of the legs and escapes near the mouth, forming the exhalent current already noted. When buried, the water must be drawn from the surrounding sand, but it must also be freed from fine sediment which soon coats the plates of the gills and interferes with respiration. If India ink be discharged on the surface of the sand above a buried crab, it will be drawn into the sand along two lines corresponding to the front borders of the shell, and closer observation will show that it passes into a crevice between the shell and the large pincers, which, when folded, accurately fit the contour of the sides of the body, here covered with a dense plush-like coat of hair. The teeth on the overhanging edge of the shell exclude large grains of sand, while the hair acts as a very efficient strainer, removing all fine particles from the inhalent stream. At times the direction of this current is reversed.

These facts explain certain of the habits. Other forms, though closely related, may lack this straining apparatus and thus be unable to burrow in sand; this is the case with *Cancer productus,* which, as a result, is restricted to rocky or gravelly bottoms. In the edible crab this straining apparatus, though efficient in removing the sediment found in the sand, seems less satisfactory in dealing with the finer particles of muddy bottoms, and crabs found in these locations have the gills badly discoloured and seldom appear healthy. Other questions, such as food and the adaptation of the legs to sand-burrowing, may have some influence, but the preference for sand is largely due to the method of respiration.

The bay specimens of this species, like those of *C. productus* and *C. antennarius,* are for the greater part much undersized. Of the total three hundred and eleven specimens taken, very few, only one or two, were really of notable size; a great number were at best of medium size, and a still greater number were small or juvenile; ninety-six measured specimens averaged only 31.6 mm. in width. This is quite in keeping with Weymouth's observations (1914, p. 124) regarding the reduction in size of this species as a result of over fishing:

The following quotation pictures the condition about 1880: "The common crabs are caught along the sandy beaches on the San Francisco side of the bay, especially on the south side of the Golden Gate between the city and the sea. They

are taken in immense numbers in seines, together with many shoal-water species of fish, yet the supply seems to be undiminished. Three or four good-sized crabs sell in the market at retail for 25 cents.'' To-day no crabs could be taken by shore-hauled seines in the locality mentioned, and very few of marketable size by any method in any part of the bay; profitable fishing is confined to the bar three or four miles outside the Golden Gate. One good-sized crab sells for 25 cents in the market on rare occasions, but more commonly for 30 or 35 cents. The supply seemed ''to be undiminished'' only because of the short time under observation. The history of this fishery, which even under protective legislation has markedly diminished in thirty years, is significant for yet unexploited regions.

We obtained eight specimens ranging from 39 to 55 mm. in width, in two hauls of the 250-foot seine at Fort Baker; at Sausalito three small individuals in a 150-foot seine; and at Tiburon with the same gear a single male, 46 mm. in width.

Outside, strange to say, not a single specimen was dredged in water exceeding 14 fathoms in depth, although on the fishing grounds, in 30 to 40 fathoms, one haul made by the commercial trawlers (July, 1912) yielded thirty-five juvenile specimens, ranging from 10 to 18 mm. in width (av. 12.5 mm.). Within the bay, except for thirty-seven specimens taken in four hauls (D 5739, 5742, 5808, 5809) in 20 to 53 fathoms, the vast majority of the records (63%) were made in less than 10 fathoms, and of these nearly half (47%) did not exceed 5 fathoms in depth.

All told, *Cancer magister* was taken at fifty-one dredging, one hydrographic, and five shore stations as follows: D 5702, 5705, 5708, 5710, 5712–5722, 5725, 5731, 5732, 5734, 5735, 5739, 5741–5743, 5745, 5749, 5750, 5752–5754, 5762–5764, 5766, 5776, 5778–5780, 5784, 5795, 5796, 5798, 5799, 5801, 5802, 5804, 5806–5809, 5816, 5818, 5819, 5822, 5825, 5826, 5828; H 5168; Sausalito, March 23, 1912; ''fishing grounds,'' July, 1912; north of Key Route Pier, August 2, 1912; Richmond shore, north of Standard Oil pier, August 3, 1912; Fort Baker, April 19 and May 13, 1913; Tiburon, April 29, 1913.

Cancer gracilis Dana

Plate 35, figure 2

Cancer gracilis Dana, Proc. Acad. Nat. Sci. Phila., **6**, 73, 1852; Crust. U. S. Expl. Exped., **1**, 153, 1852, pl. 7, fig. 2, 1855; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 52, 1900; Rathbun, H. A. E., **10**, 177, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 42, pl. 9, figs. 26–28, 1910.

Characters.—Carapace quite strongly convex, very slightly areolated; anterolateral teeth low, projecting less than one-third the length of base, not spiny-pointed; front not produced, the three median teeth reach farther forward than

the outer pair; the central tooth is smaller than the others but projects farther anteriorly. Merus of outer maxillipeds elongated, rounded anteriorly. Carpus of chelipeds with two spines, one above, at distal angle, and a second below this, on inner angle; fingers of chelipeds without dark color. Dactyls of ambulatory legs slender, not flattened.

Dimensions.—Type: length of carapace 27.3 mm., greatest width 40.2 mm. Specimens collected in San Francisco Bay ranged from 3 to 76 mm. in width of carapace.

Color.—In life color is olive overlaid with minute reddish brown spots, which are more numerous on the teeth of the anterolateral margin and on the front, giving to the whole a brownish tinge; edges of teeth, under parts, and greater portion of legs, yellowish. There is little variation in color among individuals and small difference between fresh and alcoholic specimens (Weymouth).

Type Locality.—San Francisco, California.

Distribution.—Kasaan Bay, Prince of Wales Island, Alaska, to Playa Maria Bay, Lower California. Shallow water to 56 fathoms (Rathbun).

Biological Survey of San Francisco Bay.—Cancer gracilis (see pl. 6) ranges from a little north of Point San Pedro, in the upper bay (D 5716), well down toward the lower end of the lower bay (D 5847), and outside to the San Francisco bar (D 5733) and the fishing grounds (D 5785, and by the commercial trawlers in July, 1912). In all it was taken at fourteen dredging stations and at two shore stations: Sausalito, along shore and in the seine, and Point Bonita, between tide marks. Of the dredging stations only one (D 5716) occurs in the upper bay, eight (D 5702, 5742, 5797–5799, 5826, 5828) in the middle bay, three (D 5802, 5847, 5849) in the lower bay, and two (D 5733, 5785) outside. *Cancer gracilis* occurs more abundantly at stations of 12 fathoms and less in depth. Of such there are ten at which the average number of specimens taken was two and seven-tenths. Of the other four dredging stations at which this species was taken, one is intermediate, 10 to 16 fathoms, with one specimen, and three exceed 13 fathoms (D 5702, 13 to 17 fathoms; D 5742, 20 to 30 fathoms; D 5785, 39 to 40 fathoms), with an average of one and three-tenths specimens taken at each.

There also appears to be a fairly close correspondence between depth and number of specimens per haul, and the character of the bottom. All of the stations of 12 fathoms or less within the bay were made on a predominantly muddy bottom, running from the upper bay through the eastern part of the middle bay, behind Angel Island, down into the lower bay. The station of intermediate depth designated above should be included in this series with respect to character of bottom. The outside station of less than 12 fathoms had a bottom of "fine, very clean, gray sand," and returned only a single

specimen of 23 mm. in width. The deeper stations, D 5702, off Sausalito, D 5742 in the upper end of Raccoon Strait, and D 5785, on the fishing grounds, were made on rocky, shelly, on clean dark gray sand with a few fragments of stone and occasional small compact masses of black mud, and on "fine dark green sand" bottoms respectively.

The temperatures at which this species was taken range from 8.8° to 15.9° C; while in no case was any specimen taken in water of a salinity less than 21.3.

Cancer oregonensis (Dana)

Plate 36, figures 3 and 4

Trichocera oregonensis Dana, Proc. Acad. Nat. Sci. Phila., **6**, 86, 1852; Crust. U. S. Expl. Exped., **1**, 299, 1852, pl. 18, fig. 5, 1855.

Trichocarcinus oregonensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 54, 1900.

Trichocarcinus walkeri Holmes, Occas. Papers Calif. Acad. Sci., **7**, 53, 1900.

Cancer oregonensis Rathbun, H. A. E., **10**, 178, pl. 7, fig. 1, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 49, pl. 11, fig. 34, 1910; Way, Puget Sd. Mar. Sta. Publ., **1**, 366, fig. 23, 1917.

Characters.—Carapace elliptical, more or less evenly rounded at sides, anterolateral and posterolateral margins not meeting at a distinct angle, carapace widest at seventh or eighth tooth; twelve or thirteen teeth; fronto-orbital width nearly one-half the width of the carapace. Merus of outer maxillipeds with antero-external angle produced. Carpus of chelipeds with a spine at the antero-internal angle below which there is a tooth; hand thick and high, the short upper edge of palm with two rows of small tubercles, outer surface with five delicate granulated lines; fingers of chelipeds with dark color reaching more than half the length of the outer margins, movable finger almost entirely dark colored.

Dimensions.—Type: length of carapace 18 mm., width 23 mm.; large female, 36.5 mm. long, 47.1 mm. wide (Rathbun).

Color.—Areolae bright red, chelipeds and legs flesh color, fingers black (Holmes). Dark red above, lighter beneath; walking legs in some cases with light spots which tend to give the legs a somewhat banded appearance. There is considerable variation in color; in some specimens a very irregular band of orange or yellow extends across the carapace anterior to the cardiac groove, with the whole carapace more gray and more or less spotted; in others the median line from the posterior end to beyond the cardiac groove shows very gray (Way).

Type Locality.—Puget Sound.

Distribution.—Aleutian Islands to Lower California (Holmes). Low water to 238 fathoms (Rathbun).

Family Atelecyclidae

Carapace subcircular; front with several teeth, with either a median notch or tooth. Antennules fold back longitudinally. Antennal flagella long and hairy, or wanting. Third maxillipeds overlapping endostome.

Genus **Telmessus** White

Carapace broader than long, more or less pentagonal; front divided into three lobes; median lobe cut into four teeth or denticles, lateral lobes forming the inner angles of the eyes. Chelipeds short, ambulatory legs moderately long.

Telmessus cheiragonus (Tilesius)

Cancer cheiragonus Tilesius, Mém. Acad. Impér. Sci. St. Pétersb., **5**, 347, pl. 7, fig. 1, 1815.

Telmessus cheiragonus Benedict, Proc. U. S. Nat. Mus., **15**, 224, pls. 25, 26, figs. 2–4, 1892; Holmes (mis-spelled *Telemessus*), Occas. Papers Calif. Acad. Sci., **7**, 69, 1900; Rathbun, H. A. E., **10**, 179, 1904; Way, Puget Sd. Mar. Sta. Publ., **1**, 363, fig. 17, 1917.

Fig. 139. *Telmessus cheiragonus* (from Benedict, U. S. N. M.).

Characters.—Carapace deeply areolated; teeth or denticles of median lobe of front often wanting in old worn specimens; lateral lobes triangular, forming the inner angles of the eyes; lateral teeth of carapace triangular, six in number, including the angles of the eyes, anterior three with two denticles on anterior margin, points of teeth bent forward and on a line with the denticles; the fourth tooth forms the lateral angle of the carapace and has four denticles on the anterior margin, one close to the point of the tooth, then a space followed by three denticles evenly placed; posterior teeth without denticles; surface of carapace set with large granules, forming lines in the posterior region; from these granules arise numerous bristles of even length, which bend forward and are enlarged at the points.

Dimensions.—Length of carapace 50 mm., width 64 mm. (Holmes). A large specimen measures: length of carapace 83 mm., width 102 mm. (Benedict).

Color.—Varying from a yellow-brown to dark red; the propodi, dactyls, and some portions of the carapace show the red distinctly (Way).

Type Locality.—Avacha Bay, Kamchatka.

Distribution.—Northeastern Siberia; Kamchatka; Kurile Islands; Bering Sea to California (Holmes). Low water to 20 fathoms (Rathbun).

Family Portunidae

Carapace moderately transverse, usually widest at last anterolateral marginal tooth; front with or without median tooth. Antennules fold back transversely or obliquely. Third maxillipeds not overlapping endostome. Ambulatory legs flattened, and more or less distinctly adapted for swimming.

Key to the California Genera of the Portunidae

I. Abdomen of male ⊥ shaped. Merus of outer maxillipeds prominent, and curved outward at the antero-external angle. (Not known north of Point Loma.)
Callinectes, p. 236.

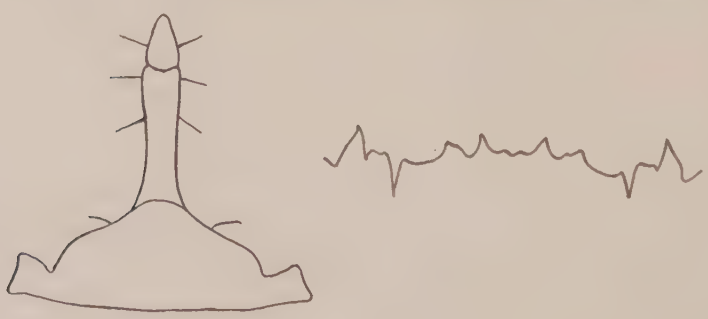
II. Abdomen of male triangular. Merus of outer maxillipeds not markedly prominent at antero-external angle, more or less obtuse.
Portunus, p. 237.

Genus **Callinectes** Stimpson

Abdomen of male very narrow, ⊥ shaped; merus of outer maxillipeds strongly produced outwardly at antero-external angle. Otherwise very similar to *Portunus*.

Callinectes bellicosus (Stimpson)

Lupa bellicosa (Sloat MS.) Stimpson, Ann. Lyc. Nat. Hist. N. Y., **7**, 57, 1859 (1862); Lockington, Proc. Calif. Acad. Sci., **7**, 105, 1877.
Callinectes bellicosus Rathbun, Proc. U. S. Nat. Mus., **18**, 365, pls. 22, 24, fig. 10, pl. 25, fig. 8, pl. 26, fig. 8, 1895; H. A. E., **10**, 180, 1904.



a *b*

Fig. 140. *Callinectes bellicosus*, slightly enlarged; *a*, abdominal outline of ♂; *b*, frontal outline (after Rathbun).

Characters.—Carapace minutely granulated; front with two slender, sharp teeth, widely separated, and between them two very faintly marked median teeth; inner supraorbital fissure open, often throughout its length; postorbital tooth long, exceeding preorbital. Carpus of chelipeds with two or three external ridges and a few pointed tubercles near the anterior end; hand with a strong spine above the upper hinge joint, at the proximal end of a tuberculated costa; ridge on the posterior upper edge ending distally in a spine; fingers obscurely if at all ridged on outer face.

Dimensions.—Male: length of carapace about 64 mm., width 134 mm.; immature female 43.5 mm., width 86 mm. (Rathbun).

Color.—Almost brown above, cream color below, the tubercles and ridges of the manus tinged with red (Lockington).

Type Locality.—Guaymas, Mexico, Gulf of California.

Distribution.—Point Loma, California, to Gulf of California (Rathbun).

Genus **Portunus** Fabricius

Carapace usually broad transversely and depressed, or a little convex, often with surface areolated; front proper well delimited from inner supraorbital angles, and cut into three to six, usually four teeth; anterolateral borders oblique, arched, longer than posterolateral, cut into nine teeth (including outer orbital angle), of which the ninth may be enlarged. Merus of outer maxillipeds not markedly produced at antero-external angle. Abdomen of male triangular.

Portunus xantusii (Stimpson)

Achelous xantusii Stimpson, Ann. Lyc. Nat. Hist., N. Y., **7**, 222, 1860 (1862).

Neptunus xantusii, A. Milne Edwards, Crust. Rég. Mex., p. 213, pl. 38, fig. 1, pl. 39, fig. 3, 1879.

Portunus xantusii Holmes, Occas. Papers Calif. Acad. Sci., **7**, 71, 1900; Rathbun, H. A. E., **10**, 179, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 49, pl. 12, fig. 35, 1910.

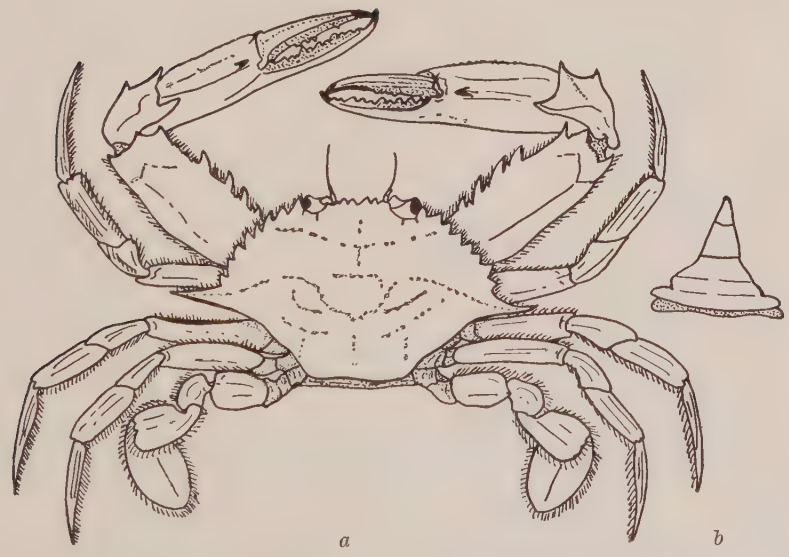


Fig. 141. *Portunus xantusii*, ♂, × 4/5; *a*, dorsal view; *b*, ventral view of abdomen (after A. Milne Edwards).

Characters.—Carapace markedly transverse, upper surface pubescent; front short, four frontal teeth equally prominent, the middle ones slightly narrower than the outer pair, and separated from the latter by a slightly wider interval than

they are separated from each other; inner supraorbital fissure more or less closed; postorbital tooth extends nearly as far forward as the teeth of the front. Carpus of chelipeds with several granulated ridges on the outer surface, a strong spine at the distal end of upper margin, and a smaller one on lower side, at distal end of lowest granulated ridge; hand with a spine at external hinge joint, the granulated ridge on the upper margin terminating in a spine a little behind the distal end of the palm; there are four granulated ridges on the outer surface of hand, not counting the upper one; fingers strongly and distinctly ridged on outer face.

Dimensions.—Type, female: length of carapace 13.7 mm., width 26.7 mm. Of male: length of carapace 25.25 mm., width 53 mm. (Holmes).

Type Locality.—Cape St. Lucas, Lower California, common on the beaches.

Distribution.—From Puget Sound to Chile. Except for a single specimen taken by the "Albatross" in Puget Sound, this species is not known north of Santa Monica Bay, California. It almost seems that the Puget Sound record is the result of an incorrect label.

Family Xanthidae (Pilumnidae)

Carapace more or less transversely oval; front moderately broad, often toothed, in the latter case always with a median notch; anterolateral margins arcuate, and armed with several lobes, teeth or spines. Antennules fold back transversely or obliquely. Fingers of chelipeds more or less curved.

Key to the California Genera of the Xanthidae

I. The ridges that define the efferent branchial channels, if present, are low and are confined to the posterior part of the endostome, never reaching the anterior part of the buccal cavern.

A. Fronto-orbital border less than half the greatest width of the carapace. (Not known north of San Pedro.)

Cycloxanthops, p. 239.

B. Fronto-orbital border half or more than half the greatest width of the carapace.

1. Carpal joints of ambulatory legs armed above with a horned or lunate crest. (Not known north of San Diego.)

Heteractaea, p. 248.

2. Carpal joints of ambulatory legs not armed with a horned crest.

a. Carapace transversely oval; front divided by an open, rounded notch. Ambulatory legs devoid of a crest on upper margin. (Not known north of Monterey.)

Xanthias, p. 245.

b. Carapace more or less hexagonal or subquadrate; front divided by a more or less closed fissure. Ambulatory legs with carpal and propodal joints more or less cristate.

Lophopanopeus, p. 240.

II. The ridges that define the efferent branchial channels extend to the anterior boundary of the buccal cavern and are often very strong. Fronto-orbital border much more than half the greatest width of carapace. Ambulatory legs not carinated. (Not known north of Venice.)

Pilumnus, p. 247.

Genus **Cycloxanthops** Rathbun

Carapace broad; front horizontal, prominent, and divided by a median fissure into two lamellate lobes, which are truncated and separated from the inner orbital angle by a rather deep fissure; orbits small, with two fissures in supraorbital margin, external orbital angles inconspicuous, continuous with anterolateral margins, which are very long, strongly curved, extending far backward; fronto-orbital border less than half the greatest width of the carapace. Abdomen of male five-jointed.

Genus **Cycloxanthops** Rathbun

Key to the California Species of Cycloxanthops

I. Carapace flattened, convex, granular and rugose in front, and more or less punctate behind. (Not known north of Monterey Bay.)
novemdentatus, p. 239.

II. Carapace very uneven, prominently granulated, and thickly covered with small circular pits. (Known only from San Diego. Not seen since originally described.)
rugosus, p. 240.

Cycloxanthops novemdentatus (Lockington)

Plate 37, figure 7

Xanthodes? novem-dentatus Lockington, Proc. Calif. Acad. Sci., **7**, 32, 1877.
Cycloxanthops novemdentatus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 56, pl. 1, fig. 2, 1900; Rathbun, H. A. E., **10**, 180, pl. 7, fig. 10, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 50, pl. 12, fig. 36, 1910; Baker, Rept. Laguna Mar. Lab., **1**, 100, 1912.

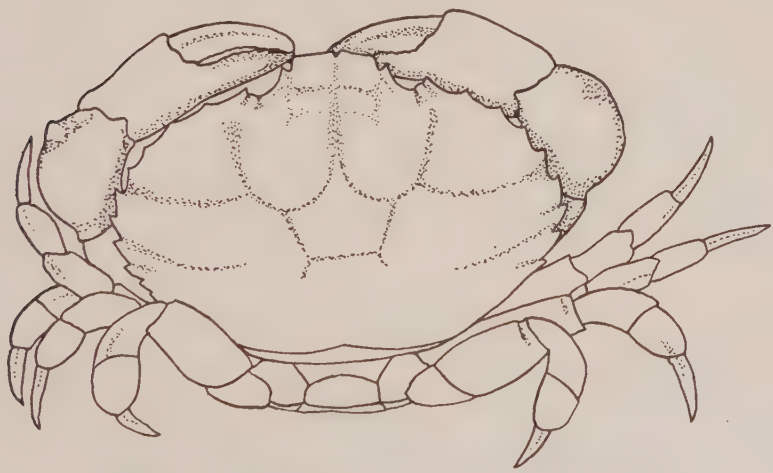


Fig. 142. *Cycloxanthops novemdentatus* (after Holmes).

Characters.—Carapace wide, slightly convex, flattened behind, punctate and anteriorly rugose; front produced, more advanced in the middle than at the orbits, with a deep, closed median notch, which may become obliterated above by

the fusion of the two sides; anterolateral margin armed with eight or nine small subacute teeth besides the postorbital; a small tenth tooth often occurs behind the ninth; preorbital tooth distinct. Merus of maxillipeds obliquely truncated at anterior end. Carpus of chelipeds rugose, and furnished with two blunt teeth at antero-internal angle; hand rugose above, and rather long, with upper and lower margins nearly parallel; fingers long, sulcate, not gaping. Ambulatory legs with margins hairy; dactyls longer than the propodi, and terminating in nearly straight, corneous claws.

Dimensions.—Type, male: length 23.9 mm., width 31.8 mm.

Color.—The general color in life is a dull reddish brown, showing traces of purple at the posterior part of the carapace and still more strongly on the ambulatory legs and below, thus somewhat resembling *Xanthias taylori;* fingers of chelipeds black, with teeth along inner margins white. One young specimen shows the tendency to white markings so common in the young of *Lophopanopeus heathii* (Weymouth).

Type Locality.—San Diego, California.

Distribution.—Monterey Bay, California, to Guadalupe and San Martin islands, Lower California.

Remarks.—Frequent under stones between tides (Baker).

Cycloxanthops rugosus Holmes

Cycloxanthops rugosa Holmes, Occas. Papers Calif. Acad. Sci., 7, 59, 1900.
Cycloxanthops rugosus Rathbun, H. A. E., 10, 180, 1904.

Original Description.—Carapace very uneven, granulated, and thickly covered with small, circular pits. Postorbital tooth small; anterolateral teeth irregular. Anterior portion of the subhepatic region prominently granulated and pitted and not sharply separated from the strongly sloping anterior portion of the hepatic area. Front shorter and more depressed than in *novemdentatus.* External maxillipeds much as in the preceding species; merus pitted and granulated. Carpus of the chelipeds strongly reticulated above; a prominent tooth at the antero-internal angle, below which is a smaller tooth. Hands narrow, strongly reticulated above and on the upper portion of the outer surface, the inner margin of the upper side furnished with several irregular tubercles. Ambulatory legs much as in *novemdentatus* but less hairy (Holmes).

Type Locality.—San Diego, California.

Remarks.—This species has not been found since Holmes's original specimen was taken and described (no measurements were given). Holmes says it is "easily distinguished by the conspicuous pits and prominent granulations of the carapace."

Genus Lophopanopeus Rathbun

Carapace more or less hexagonal or subquadrate; front short, divided by a closed or nearly closed fissure into two sinuous lobes; orbits transverse; postorbital tooth small, anterior half of anterolateral margin more or less straight, furnished with a single low obscure tooth which is more or less coalesced with the postorbital, posterior half of anterolateral margin nearly longitudinal and furnished with three prominent, subequal teeth; fronto-orbital border half or more than half the greatest width of the carapace. Ambulatory legs more or less cristate. Abdomen of male five jointed.

KEY TO THE CALIFORNIA SPECIES OF LOPHOPANOPEUS

I. Hands smooth, without lobes or teeth on upper margin; dark color of fingers does not run back on the palm.
bellus, p. 241.

II. Hands with one or more lobes or teeth on upper margin.
A. Carpus of chelipeds smooth or nearly so.
1. Color of fingers runs back on palm. (Not known north of Venice.)
frontalis, p. 242.
2. Color of fingers does not run back on palm. (Not known north of Monterey Bay.)
heathii, p. 243.
B. Carpus of chelipeds very rough.
1. Carpal joints of ambulatory legs strongly bilobed. Color of fingers does not run back on palm.
a. Carpus of chelipeds with reticulating ridges enclosing pits of irregular shape. (Not known north of Monterey.)
leucomanus, p. 243.
b. Carpus of chelipeds covered with tubercles. (Not known north of Monterey Bay.)
diegensis, p. 245.
2. Carpal joints of ambulatory legs slightly bilobed. Carpus of chelipeds is crossed by a few thickened ridges incompletely reticulating, anterior margin having a thick, granulated ridge, distinctly separated by a deep sulcus from the rest of the carpus; a large granulated tubercle near articulation with hand; color of fingers does not run back on palm. (Not known north of Venice.)
lockingtoni, p. 244.

Lophopanopeus bellus (Stimpson)

Plate 37, figure 4

Xantho bella Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 204, pl. 5, fig. 2, 1860 (1862).

Lophoxanthus bellus A. Milne Edwards, Crust. Rég. Mex., p. 257, pl. 46, fig. 4, 1879 (part); Holmes, Occas. Papers Calif. Acad. Sci., 7, 60, pl. 1, fig. 3, 1900.

Lophopanopeus bellus Rathbun, H. A. E., 10, 180, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 51, pl. 12, fig. 37, 1910.

Fig. 143. *Lophopanopeus bellus*, carapace (after Holmes).

Characters.—Carapace is roughened anterolaterally but not conspicuously so; frontal lobes are slightly sinuous and oblique, the outer tooth faintly indicated. Carpus of chelipeds is slightly roughened in the older specimens, but it often is roughly tuberculous in young ones; hand smooth, without a tooth on the upper

margin; the proximal end of the inner margin of the upper surface is, however, well marked; dark color of fingers does not run back on palm. Carpal joints of ambulatory legs slightly bilobed on the anterior or upper margin; propodal joints have a convex anterior margin without lobes.

Dimensions.—Type, male: length of carapace 13.7 mm., width 20.3 mm. Male specimen examined by Miss Rathbun: length 22.5 mm., width 33.8 mm., proportion of length to width 1 : 1.5, fronto-orbital width 16 mm., proportion of fronto-orbital width to width of carapace 1 : 2.11.

Color.—Crimson or beet red; carapace sometimes lighter in color, or yellowish, maculated with deep red. Northern specimens are more transverse, rougher, more pubescent, and more sober in coloration than those found in warmer latitudes (Stimpson). Color in life of this species as of *Lophopanopeus heathii* is extremely variable.... Some specimens are almost pure white while others show various irregular patterns of bluish and dark red or are wholly of the latter color (Weymouth).

Type Locality.—Monterey, California.

Distribution.—Prince William Sound; Kasaan Bay, Prince of Wales Island, Alaska (Rathbun). Vancouver Island, British Columbia to Monterey Bay, California (Holmes). Lower California (A. Milne Edwards).

Remarks.—Miss Rathbun says: "There are on the Pacific Coast six closely allied species of *Lophopanopeus;* some of these have been confused with *L. bellus* and *L. leucomanus;* therefore the published localities from which I have not examined specimens, are accepted with a reservation."

In the collection of the U. S. National Museum this species is not represented from any locality south of Puget Sound.

Lophopanopeus frontalis (Rathbun)

Plate 37, figure 3

Lophozozymus (*Lophoxanthus*) *frontalis* Rathbun, Proc. U. S. Nat. Mus., 16, 236, 1893.

Lophoxanthus frontalis Holmes, Occas. Papers Calif. Acad. Sci., 7, 64, pl. 1, figs. 5–6, 1900.

Lophopanopeus frontalis Rathbun, H. A. E., 10, 181, pl. 7, fig. 8, 1904.

a *b*

Fig. 144. *Lophopanopeus frontalis; a,* chela; *b,* carapace (after Holmes).

Characters.—Carapace almost smooth; frontal lobes markedly oblique and sinuous, middle lobes very convex. Carpus of chelipeds is smoother than in *L. bellus;* hand smooth, with a large tooth projecting inward on the inner side of the upper margin, and extending half the length of the upper margin; dark color of fingers runs back on the palm, in this respect differing from all other allied species. Carpal joints of ambulatory legs are slightly bilobed on the anterior or upper margin; propodal joints have a convex anterior margin but are narrower than in *L. bellus.*

Dimensions.—Male: length 17.2 mm., width 23.7 mm., proportion of length to width of 1:1.32; fronto-orbital width 12.5, proportion of fronto-orbital width to width of carapace 1:1.9 (Rathbun).

Color.—The dark color of the fingers runs back on the palm, in this respect differing from all other allied species (Rathbun).

Type Locality.—San Diego, California.

Distribution.—Santa Monica Bay and Santa Catalina Island to San Diego, California.

Lophopanopeus heathii Rathbun

Plate 37, figure 1

Lophopanopeus heathii Rathbun, Amer. Nat., **34**, 137, 1900.

Lophoxanthus leucomanus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 61, 1900 (part).

Lophopanopeus heathii Rathbun, H. A. E., **10**, 182, pl. 7, fig. 9, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 51, pl. 12, fig. 38, 1910; Hilton, Jour. Ent. Zool., Pomona Coll., **8**, 71, 1916.

Characters.—Carapace smooth except on outer half of hepatic region, where it is slightly roughened; margin of frontal lobes slightly oblique, outer tooth inconspicuous. Carpus of chelipeds smooth or nearly so; hand smooth, one tooth on inner side of upper margin; dark color of fingers not running back on the palm. Carpal joints of ambulatory legs with anterior or upper margin slightly bilobed; propodal joints with slightly convex anterior margins.

Dimensions.—Type, male: length 12.2 mm., width 16.5 mm., proportion of length to width 1:1.35; fronto-orbital width 11.6 mm., proportion of fronto-orbital width to width of carapace, 1:1.42 (Rathbun).

Color.—Extremely variable, see note under *L. bellus.* Hilton remarks: "A young male was marked as follows: white claws with dark tips, last legs white, other legs and body dark red. A young female had red claws, hind legs white and body darker. Another young male was white."

Type Locality.—Monterey Bay, California.

Distribution.—Monterey Bay, Santa Catalina Island, and Laguna Beach, California.

Lophopanopeus leucomanus (Lockington)

Plate 37, figure 6

Xanthodes leucomanus Lockington, Proc. Calif. Acad. Sci., **7**, 32, 1877 (not *leucomanus*, p. 100).

Lophoxanthus leucomanus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 61, pl. 1, fig. 4, 1900 (part).

Lophopanopeus leucomanus Rathbun, H. A. E., **10**, 182, 1904; Baker, Rept. Laguna Mar. Lab., **1**, 100, fig. 53, 1912.

Fig. 145. *Lophopanopeus leucomanus*, carapace (after Holmes).

Characters.—Carapace with anterior half deeply rugose, the roughness on the hepatic region not divided from that on the two adjacent teeth; frontal lobes strongly oblique, except the outer tooth, which is quite strongly marked. Carpus of chelipeds covered with numerous small, irregular pits, separated by reticulating lines; upper portion of hand pitted, reticulated like carpus, and with two or more irregular, inwardly directed teeth on upper margin, the proximal one being the larger; dark color of fingers not running back on palm. Carpal joints of ambulatory legs have on the anterior or upper margin a very thin crest, strongly bilobed; propodal joints are wide, and have a prominent lobe at the proximal end.

Dimensions.—Type: length 8.6 mm., width 12.7 mm. A male, examined by Miss Rathbun: length 8.7 mm., width 11.6 mm., proportion of length to width 1 : 1.33, fronto-orbital width 7.1 mm., proportion of fronto-orbital width to width of carapace 1 : 1.63.

Type Locality.—Monterey, California.

Distribution.—From Monterey to San Diego, California (Rathbun).

Remarks.—Occasional under stones between tides (Baker).

Lophopanopeus lockingtoni Rathbun

Plate 37, figure 2

Xanthodes leucomanus Lockington, Proc. Calif. Acad. Sci., 7, 100, 1877 (not *X. leucomanus*, p. 32).

Lophoxanthus leucomanus Holmes, Occas. Papers Calif. Acad. Sci., 7, 61, 1900 (part).

Lophopanopeus lockingtoni Rathbun, H. A. E., 10, 183, pl. 7, fig. 7, 1904.

Characters.—Carapace with anterior half irregularly roughened; the obliquely oval granulated patch on the hepatic region separated from the granules on the adjacent teeth; frontal lobes slightly oblique but the outer tooth well marked. Carpus of chelipeds crossed by a few thickened ridges incompletely reticulating, anterior margin having a thick granulated ridge distinctly separated by a deep sulcus from the rest of the carpus; a large tubercle near the articulation with the hand; upper margin of hand with two longitudinal ridges, outer one straight, the inner curved and ending proximally in a tooth; outer surface of hand granulate, granules tending to form in longitudinal and transverse lines, and becoming fainter toward the fingers; dark color of fingers not running back on palm. Carpal joints of ambulatory legs distinctly but not markedly bilobed on the anterior or upper margin; the propodal joints with a slightly convex anterior margin.

Dimensions.—Type, male: length of carapace 9.6 mm., width 13.3 mm., proportion of length to width 1:1.39; fronto-orbital width 7.9 mm., proportion of fronto-orbital width to width of carapace 1:1.68.

Color.—Shows great variation, some have black fingers with white tips, others have colored fingers, and the general tint of the carapace varies considerably (Lockington).

Type Locality.—San Diego Bay, California.

Distribution.—San Pedro, California, to Gulf of California (Rathbun).

Lophopanopeus diegensis Rathbun

Plate 37, figure 5

Lophopanopeus diegensis Rathbun, Amer. Nat., **34**, 137, 1900; H. A. E., **10**, 184, pl. 9, fig. 3, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 52, pl. 12, fig. 39, 1910.

Fig. 146. *Lophopanopeus diegensis*, ♂, × 1⅘ (from Rathbun).

Characters.—Carapace with a few granulate lines on the anterolateral regions; frontal lobes slightly oblique and sinuous, outer tooth inconspicuous. (The front is deflexed so that its true edge does not show in the view figured.) Carpus of chelipeds with about thirty-five irregularly placed tubercles, some of them forming lines; hand bicarinate above, the inner carina having a small prominence at the proximal end; inner surface of hand with a few tubercles on upper part; outer surface with upper and proximal portion rough, with five granulated rugae; dark color of fingers not running back on palm. Carpal joints of ambulatory legs with two prominent, naked, truncate tubercles on the anterior margin, a character by which this species may at once be recognized; propodal joints with a slightly convex anterior margin.

Dimensions.—Type, male: length 7.9 mm., width 11.4 mm., proportion of length to width 1:1.44; fronto-orbital width 6.6 mm., proportion of fronto-orbital width to width of carapace 1 : 1.37.

Color.—In life dull brown or blackish, occasionally tinged with red but never conspicuously marked as in *L. heathii* (Weymouth).

Type Locality.—San Diego, California.

Distribution.—Monterey Bay to San Diego Bay, California, 10 to 31 fathoms (Rathbun).

Genus **Xanthias** Rathbun

Carapace transversely oval; front broad, bilobed; anterolateral border cut into three or four tuberculiform or even spinous lobes or teeth, fronto-orbital border considerably more than half the greatest width of the carapace. Ambulatory legs devoid of a crest, but more or less spinous or granular on upper margin. Abdomen of male five-jointed.

Key to the California Species of Xanthias

I. Movable fingers of chelae very long and curved abruptly downward. (Only one specimen known, from San Diego.)
latimanus, p. 247.

II. Movable fingers of chelae stout, not abruptly curved downward. (Not known north of Monterey.)
taylori, p. 246.

Xanthias taylori (Stimpson)

Plate 37, figure 8

Xanthodes taylori Stimpson, Ann. Lyc. Nat. Hist. N. Y., 7, 208, pl. 3, fig. 3, 1860 (1862); A. Milne Edwards, Crust. Rég. Mex., p. 260, pl. 45, fig. 3, 1879.

Xanthias taylori Holmes, Occas. Papers Calif. Acad. Sci., 7, 65, 1900; Rathbun, H. A. E., 10, 185, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 52, pl. 13, fig. 40, 1910; Baker, Rept. Laguna Mar. Lab., 1, 102, fig. 54, 1912.

Fig. 147. *Xanthias taylori*, ♂, chela, slightly enlarged (after A. Milne Edwards).

Characters.—Carapace flat behind, in front quite strongly convex longitudinally but nearly plane transversely; lobes of front separated by a wide, rounded notch and furnished with a rounded tooth at the inner and outer angles, between which are several small baccate protuberances; inner orbital angle prominent, separated by a deep notch from outer angle of front; upper orbital margin with a rounded tooth which is bounded by a pair of sulci; postorbital tooth small and continuous externally, with a rounded protuberance; the latter separated by a smooth sulcus from a pair of smooth, rounded prominences, one of which is situated directly above the other; the three posterior teeth on the anterolateral margin prominent, the last two curved forward, the first obtuse and generally more or less bifid; usually there is a small tooth behind the one at the anterolateral angle. Chelipeds stout, more or less unequal; carpus thickly covered with prominent, rounded, smooth, glossy, rose colored tubercles; hand oblong, with palm longer than wide, upper and outer surface covered with tubercles like those on the carpus, arranged in seven or eight longitudinal rows; fingers stout and black colored, color not extending back upon hand.

Dimensions.—Type, female: length of carapace 17.3 mm., width 27.7 mm. An egg-laden female measures 24.6 mm. long on the median line of the carapace and 42 mm. wide (Rathbun).

Color.—In life a uniform dark red, lighter below, fingers black (Weymouth). In the alcoholic specimen the carapace is rose color, like the tubercles of the chelipeds, which are set on a bluish ground; fingers black, the black not spreading on the hand (Stimpson).

Type Locality.—Monterey, California.

Distribution.—Monterey, California, to Magdalena Bay, Lower California. Beach to 55 fathoms (Rathbun).

Remarks.—Abundant under stones between tides and also in kelp holdfasts from deeper water (Baker).

Xanthias latimanus (Lockington)

Xanthodes latimanus Lockington, Proc. Calif. Acad. Sci., 7, 31, 1877.

Xanthias latimanus Holmes, Occas. Papers Calif. Acad. Sci., 7, 66, 1900; Rathbun, H. A. E., 10, 185, 1904.

Characters.—Carapace but slightly transverse; front sinuate, inner angle of orbit raised into a point. Hands of chelipeds subequal, the right somewhat the larger; movable fingers very long and curved abruptly downward; margin of hand continuous with the broad base of the fixed finger so as to form a sinuous sloping line.

Dimensions.—Type, male: length 18.5 mm., width 22.4 mm.

Type Locality.—San Diego, California. Not seen since Lockington's record.

Remarks.—This species may readily be identified by the delicate marbling of the carapace and chelipeds, and the downward bend of the movable fingers (Lockington).

Genus **Pilumnus** Leach

Carapace transversely oval or subquadrilateral, not greatly broader than long; front usually about a third the greatest width of the carapace, sometimes broader, cut into two lobes, the outer angle of each of which commonly forms an independent dentiform or spiniform lobule, separated from supraorbital angle by a groove or notch; orbits generally have a gap or fissure just below outer angle and one or two gaps or notches in upper border; anterolateral margins not longer than the posterolateral, commonly shorter, and cut into teeth which very commonly are spiniform; fronto-orbital border much more than half the greatest width of the carapace. Ambulatory legs generally covered thickly with hair, not carinated, usually stout, and of moderate length. Abdomen of male seven-jointed.

Pilumnus spinohirsutus (Lockington)

Plate 37, figure 10

Acanthus spino-hirsutus Lockington, Proc. Calif. Acad. Sci., 7, 32 and 102, 1876 (1877).

Pilumnus spino-hirsutus Holmes, Occas. Papers Calif. Acad. Sci., 7, 67, 1900.

Pilumnus spinohirsutus Rathbun, H. A. E., 10, 185, pl. 7, fig. 2, 1904.

Characters.—Carapace strongly convex, nearly smooth, but covered with stiff setae; median frontal lobes truncated, separated by a prominent notch, each armed with four or five spines; lateral lobes of front small, separated from the median lobes by a deep notch and ending in a spine; orbits with upper, lower and outer margins armed with strong spines of unequal size, the two spines at the intero-inferior angle large and situated on a kind of lobe; besides the post-orbital the anterolateral margin is armed with three strong spines in front of the first of which is a small spine below the margin. Chelipeds unequal, setose; carpus with outer surface thickly covered with spines; upper and outer surface of hand covered with several series of spines, lower margin finely denticulated, fingers dark colored.

Dimensions.—Type: length 25.4 mm., width 28.4 mm.

Color.—One peculiarity of this form is the bright red tint of the prominent transverse ridge in front of the buccal area (Lockington).

Type Locality.—San Diego, California.

Distribution.—Venice to San Diego, California, and Gulf of California; 10 to 22 fathoms (Rathbun). Bay of St. Elena, Ecuador (Nobili).

Genus **Heteractaea** Lockington

Similar in form to *Pilumnus* but lacking the palatal ridges which define the efferent branchial channels in that genus; fronto-orbital border half or more than half the greatest width of the carapace. Ambulatory legs armed above with a curiously shaped horned or lunate crest. Abdomen of male five-jointed.

Heteractaea lunata (Milne Edwards and Lucas)

Plate 37, figure 9

Pilumnus lunatus Milne Edwards and Lucas, *in* D'Orbigny's Voy. dans l'Amér. mérid., Crust., 6, pt. 1, p. 20, 1843, pl. 9, fig. 2, 1847.

Heteractaea pilosus Lockington, Proc. Calif. Acad. Sci., 7, 97, 1876 (1877).

Heteractaea lunata A. Milne Edwards, Crust. Rég. Mex., p. 301, pl. 52, fig. 2, 1879; Rathbun, H. A. E., 10, 185, 1904.

Characters.—Carapace quite thickly tomentose, with exception of the smooth, shining and naked anterior margin of the frontal lobes, upper and under margins of orbit, and a small tooth just external to the outer hiatus of the orbit; upper margin of orbit a thick, long, sinuate tubercle; anterolateral margin with three sharp teeth projecting beyond the tomentum. Chelipeds unequal, tomentose; carpus and hands covered with tubercles which are arranged in regular rows on the outer side of the hand.

Dimensions.—Specimens examined by Lockington: greatest length of male 19 mm., of female 15 mm., greatest width 27 and 20 mm. respectively.

Color.—In alcohol the teeth of front, upper and under margins of orbit, and a small tooth just external to the outer hiatus of the orbit are all red, smooth, shining and naked; remainder of upper surface of carapace thickly tomentose. Tubercles of manus and carpus red, the red predominating at distal end of merus (Lockington).

Type Locality.—Valparaiso, Chile.

Distribution.—San Diego, California (Faxon), to Chile.

Family Goneplacidae

Carapace squarish, front quite broad, frequently with a median notch; orbits transversely elongated, eye-stalks long; anterolateral angles spiniform. Antennules fold back transversely or obliquely. Fingers of chelipeds practically straight longitudinally.

Genus **Speocarcinus** Stimpson

Carapace longitudinally convex, almost semi-cylindrical, transversely nearly flat, posteriorly narrowing very little, anteriorly margins arcuate and dentate; front less than half the width of the carapace; orbits marginal, oblong. Outer maxillipeds moderately separated from each other, merus subquadrate, with a notch at antero-internal angle for the insertion of palp. Abdomen of male with base much narrower than the last thoracic sternum; third, fourth, and fifth segments coalesced.

Spe ocarcinus californiensis (Lockington)

Plate 34, figure 7

Eucrate? californiensis Lockington, Proc. Calif. Acad. Sci., **7**, 33, 1876 (1877).

Speocarcinus californiensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 77, 1900; Rathbun, H. A. E., **10**, 190, pl. 9, fig. 1, 1904; Bull. U. S. Nat. Mus., **97**, 42, text fig. 16, pl. 10, figs. 2–3, 1918.

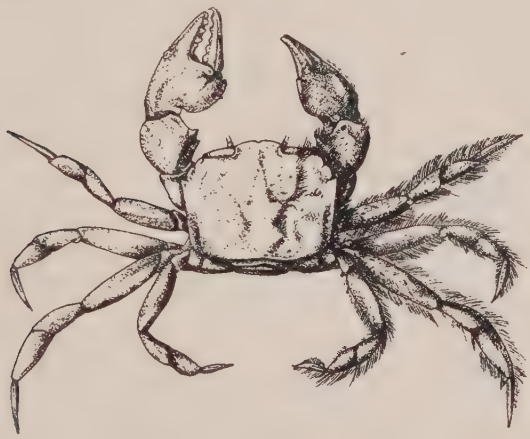


Fig. 148. *Speocarcinus californiensis*, ♂, × 1⅕ (from Rathbun).

Characters.—Carapace nearly smooth above but minutely granulated toward the pubescent margins; front over one-fourth the width of the carapace, anterior margin nearly straight and emarginate in the center; anterolateral margin strongly curved and furnished with three teeth, including the postorbital; the first two teeth are thin-edged and lobate, second tooth broadly rounded, and the third acute. Outer maxillipeds diverging anteriorly, the merus distally truncated, with antero-external angle rounded and not produced. Chelipeds unequal; carpus with a spine at the antero-internal angle and a short, longitudinal granulated ridge at the distal end of the outer surface; hands wide, much compressed, outer surface nearly smooth, but granulated near the upper and lower margins, upper edge acute and sharply granulated; fingers ridged, immovable finger not deflexed. Last pair of ambulatory legs upturned, and to a less extent the preceding pair also.

Dimensions.—Type: length of carapace 20.8 mm., width 26.9 mm.

Type Locality.—San Diego, California.

Distribution.—San Pedro, Anaheim Creek, and Alamitos Bay to San Diego, California.

Remarks.—Lives in holes in muddy beaches (Holmes).

Family Pinnotheridae

Carapace somewhat rectangular but frequently more or less rounded, usually more or less membranaceous; front, orbits, and eye-stalks usually very small, often rudimentary; anterolateral margin indistinct, entire. Antennules fold back transversely in an oblique direction. Small commensal or symbiotic crabs, living symbiotically or parasitically in the shells of bivalve molluscs, corals, echinoderms, and worm tubes.

In case any difficulty is encountered in identifying any of the representatives of this usually puzzling family, the student should consult Miss Rathbun's very excellent monograph covering them (Bull. U. S. Nat. Mus., 97, 1918). The keys here given have been abstracted from it, as well as the original descriptions of recently discovered forms, several plates, a few notes, and remarks.

Key to the California Genera of the Pinnotheridae

I. Ischium of external maxillipeds rudimentary or indistinguishably fused with merus, forming a single piece which sometimes lies transversely but usually obliquely across the buccal cavity; palp not more than half as large as merus-ischium.

A. Carapace suborbicular or subquadrate, not strikingly wider than long. Ambulatory legs not successively diminishing in length from first to fourth.

1. Carapace without two longitudinal, impressed lines leading back from the middle of upper margin of orbit. Female larger than male and usually ill-calcified.

Pinnotheres, p. 250.

2. Carapace with two longitudinal, impressed lines leading back from middle of upper margin of orbit. Male unknown.

Fabia, p. 253.

B. Carapace much broader than long, anterior margin nearly straight. Ambulatory legs diminishing in length from first to last, last very small. (Known only from San Pedro.)

Parapinnixa, p. 255.

II. Ischium of external maxillipeds usually distinct from merus, though smaller and sometimes imperfectly united with it; palp of good size, usually about as large as merus-ischium. Carapace transverse, usually broadly so.

A. Carapace much wider than long. Third pair of ambulatory legs the longest.

1. Third pair of ambulatory legs markedly larger and longer than the others. Carapace more or less membranaceous; lower, or true anterolateral margin forming an angle with posterolateral margin.

Pinnixa, p. 255.

2. Third pair of ambulatory legs not markedly longer than the others, legs more or less subequal. Carapace hard; lower, or true antero-lateral margin curving gradually into posterolateral margin.

Scleroplax, p. 267.

B. Carapace very little wider than long; suborbicular. Ambulatory legs more or less subequal, second pair the longest. (Not known north of Monterey Bay.)

Opisthopus, p. 268.

Genus **Pinnotheres** Latreille

Carapace smooth, more or less membranaceous, sometimes quite hard; suborbicular or pentagonal, scarcely wider than long; sometimes a little longer than wide, without longitudinal sulci behind the orbits. Outer maxillipeds oblique; ischium rudimentary; merus large and usually curved; palp three-jointed; last joint either articulated to inner margin of preceding one, or to its antero-external angle. Ambulatory legs subequal, of moderate length; third pair very little if any longer than the others.

KEY TO THE CALIFORNIA SPECIES OF PINNOTHERES

I. Palp of outer maxillipeds small, much less than half as large as merus. Carapace wider than long. Dactyls of ambulatory legs falcate, terminating in slender, curved, corneous tips; dactyls of second pair of ambulatory legs the longest. Male unknown. (Known only from the type locality, Pacific Grove.)
holmesi, p. 251.

II. Palp of outer maxillipeds large, nearly half as large as merus.
A. Carapace wider than long, though nearly square; with rounded corners; naked. Dactyls of ambulatory legs nearly straight, those of fourth pair of ambulatory legs longer and more slender than the others. Male unknown. (From Monterey and Santa Cruz, not found since these two records were made by Holmes.)
nudus, p. 252.

B. Carapace as long as or longer than wide. Dactyls of ambulatory legs falcate, terminating in slender, curved, corneous tips; dactyls similar.
concharum, p. 252.

Pinnotheres holmesi Rathbun

Plate 39, figures 7 and 8

?Pinnotheres nudus Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 53, fig. 1, 1910; not *P. nudus* Holmes, 1895.

Pinnotheres holmesi Rathbun, Bull. U. S. Nat. Mus., 97, 68, text fig. 31, pl. 15, figs. 1–2, 1918.

Original Description of Female.—Carapace very soft and yielding, broader than long, the front and long antero-lateral margins forming a single arch; postero-lateral margins short, oblique, concave; posterior margin long, concave; greatest width in posterior half; carapace convex, thick, rounding gradually downward, except posteriorly; gastric region defined by a depression.... Front between orbits truncate, medially faintly emarginate, orbits partly visible from above.

Carpus of outer maxilliped suboblong; propodus no longer than carpus, and narrower, end obliquely rounded; dactylus linear, of nearly even width throughout, rounded at extremity, inserted near proximal end of propodus and not reaching its distal end.

Chelipeds stouter than [ambulatory] legs, but not very large; lower margin of propodus nearly straight, palmar portion widening rapidly to a point behind base of fingers; fingers stout, hooked at tips, prehensile edges uneven, an acute tooth near base of dactyl.

Relative length of [ambulatory] legs represented by 2, 3, 1, 4, the second longest; 2, 3, and 4 very slender; dactyl 2 much longer than 3 or 4 and curved on both margins, dactyl 3 less curved on anterior and nearly straight on posterior margin, dactyl 4 a trifle longer than 3, margins nearly straight; horny tips of all four very slender and hooked. First leg stout, especially propodus, not reaching middle of propodus of second; propodus widest distal to the middle and narrowest at distal extremity; dactyl shortest of all, conical except for tip.

Abdomen voluminous, much longer and wider than carapace (Rathbun).

Dimensions.—Type, female: length of carapace 7.2 mm.; width 8.7 mm.

Type Locality.—Probably Pacific Grove; known only from a single ovigerous female specimen.

Pinnotheres nudus Holmes

Pinnotheres nudus Holmes, Proc. Calif. Acad. Sci., (2), **4**, 563, figs. 1–5, 1894 (1895); Occas. Papers Calif. Acad. Sci., **7**, 86, 1900; not *P. nudus* Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 53, fig. 1, except synonymy; Rathbun, Bull. U. S. Nat. Mus., **97**, 83, fig. 40, 1918.

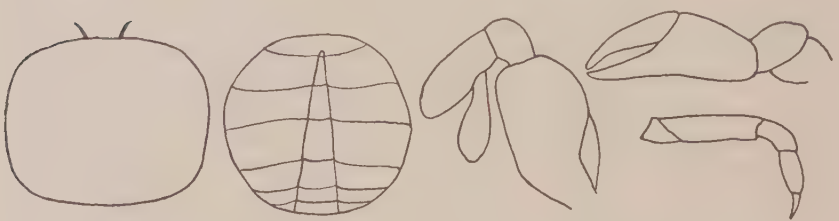


Fig. 149. *Pinnotheres nudus*, ♀, slightly enlarged; *a*, outline of carapace; *b*, outline of abdomen; *c*, outer maxilliped; *d*, left cheliped; *e*, first ambulatory leg (after Holmes, from Rathbun).

Characters.—Carapace a little broader than long, smooth, and naked; front rounded, deflexed, not protruding; orbits ovate. Antennules oblique. Palp of outer maxillipeds nearly half as large as merus. Three anterior pairs of ambulatory legs subequal, fourth pair smaller; dactyls acute, nearly straight, those of the fourth pair relatively longer and more slender than those of preceding legs. Abdomen of female nearly circular in outline, covers entire sternal surface.

Dimensions.—Types, two females: length of carapace 20 mm. and 15.5 mm., width 24 mm. and 19 mm., respectively.

Type Locality.—Santa Cruz, California.

Distribution.—Monterey and Santa Cruz, California (Holmes).

Remarks.—This species has not been found since the records, noted above, were made by Holmes.

Pinnotheres concharum (Rathbun)

Plate 38, figures 1, 2, 3, and 4

Cryptophrys concharum Rathbun, Proc. U. S. Nat. Mus., **16**, 250, 1893; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 96, 1900; Rathbun, H. A. E., **10**, 188, pl. 7, fig. 6, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 60, 1910; Rathbun, Bull. U. S. Nat. Mus., **97**, 86, text fig. 42, pl. 20, figs. 3–6, 1918.

Characters.—Carapace subpentagonal, slightly longer than broad, smooth, rigid, a faint sulcus behind the gastric region; anterior and anterolateral margins defined by a ridge of coarse setae, which are thickest and longest at the anterolateral angles; orbits circular. Antennules large, nearly transverse. Palp of outer maxillipeds nearly half as large as merus. Three anterior pairs of ambulatory legs subequal, the second the longest; the fourth pair the shortest, overreaching the carpal joint of the preceding pair; dactyli about as long as the propodi, terminating in slender, curved hooks. Abdomen of male broadest near proximal end of the second segment; first segment short; second, third, and fourth segments coalesced, first two of these fused segments convex on the margin and

separated by a faint line, the last one slightly concave on the margin; fifth and sixth abdominal segments broader than long; terminal segment subrectangular.

Dimensions.—Type, male: length 4.7 mm., width 4.2 mm.

Type Locality.—False Bay, San Diego County, California.

Distribution.—British Columbia to San Diego, California.

Remarks.—Commensal in bivalve mollusks: *Cardita, Kellia, Donax, Mya, Mytilus,* and ascidians: *Phallusia;* sometimes free-swimming (Rathbun).

Genus **Fabia** Dana

Carapace smooth, more or less membranaceous, not much wider than long, suborbicular or subquadrate, marked with a pair of longitudinal sulci enclosing the median area. Outer maxillipeds with ischium rudimentary and merus large; palp three-jointed, third joint articulated on the inner margin of the preceding one. Ambulatory legs subequal and rather slender; second pair longest.

Key to the California Species of Fabia

I. Legs of second ambulatory pair alike.

A. Turned-down front, with a shallow transverse sulcus which is covered with pubescence. Palm of chelipeds widened distally. (Not known south of Laguna Beach.)
subquadrata, p. 253.

B. Front naked, without trace of a transverse groove. Palm of chelipeds not widened distally. (Not known north of San Pedro.)
lowei, p. 254.

II. Legs of second ambulatory pair unlike, the right longer than the left. Front naked, with a short longitudinal median depression. Palm of chelipeds widened distally. (Known only from Monterey.)
canfieldi, p. 254.

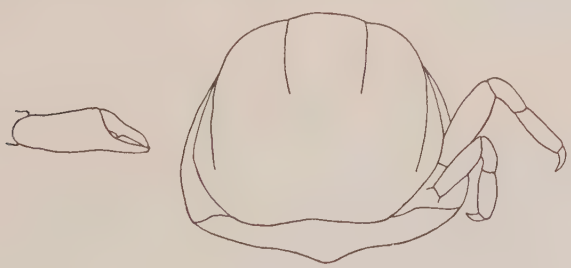
Fabia subquadrata (Dana)

Plate 39, figures 1 and 2

Fabia subquadrata Dana, Proc. Acad. Nat. Sci. Phila., 5, 253, 1851; Crust. U. S. Expl. Exped., 1, 382, 1852, pl. 24, fig. 5, 1915; Holmes, Occas. Papers Calif. Acad. Sci., 7, 87, 1900 (part).

Raphonotus subquadratus Rathbun, H. A. E., 10, 186, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 55, fig. 2, 1910.

Fabia subquadrata Rathbun, Bull. U. S. Nat. Mus., 97, 102, fig. 53, pl. 24, figs. 1, 3, 1918.



a *b*

Fig. 150. *Fabia subquadrata,* ♀, × 1¾; *a,* chela; *b,* dorsal view of carapace (after Weymouth).

Characters.—Carapace smooth, glossy, membranaceous, subquadrate in outline, with the angles broadly rounded; the space between the longitudinal sulci is longer than wide and slightly narrowed behind; anterolateral margin rounded and marked by round cluster of pits; front abruptly turned down, with a shallow transverse sulcus covered with pubescence. Antennules obliquely plicated in very wide fossettes. Last joint of outer maxilliped reaches the end of the preceding joint. Palm of chela widens a little distally and is furnished with two rows of hair below, the inner one of which is continued to the end of the immovable finger.

Dimensions.—Type, female: length of carapace 12.2 mm., width 14.3 mm.

Type Locality.—Puget Sound.

Distribution.—Alaska to Laguna Beach, California (Rathbun).

Remarks.—Commensal in bivalve mollusks: *Mya* and *Mytilus* (Rathbun).

Fabia lowei Rathbun

Plate 39, figures 3 and 4

Fabia subquadrata Holmes, Occas. Papers Calif. Acad. Sci., 7, 87, 1900 (part).

Raphonotus lowei Rathbun, H. A. E., 10, 186, text fig. 93, 1904.

Fabia lowei Rathbun, Bull. U. S. Nat. Mus., 97, 104, text fig. 55, pl. 24, figs. 2, 4, 1918.

Fig. 151. *Fabia lowei,* chela, ♀ × 4 (after Rathbun).

Characters.—Very similar to *F. subquadrata,* with carapace a little wider; turned-down front naked, with no trace of a transverse groove. Last joint of outer maxilliped does not reach the end of the preceding joint. Palm of chela, not widening distally, its margins subparallel or a little convex; lower surface with but one line of hair, which is continued to the end of the immovable finger; fingers less arched and less gaping than in *F. subquadrata.*

Dimensions.—Type, female: length of carapace 10 mm., width 12.5 mm.

Color.—In life whitish in color; carapace and abdomen largely orange color (Holmes, as *F. subquadrata*).

Type Locality.—San Pedro Bay, California.

Distribution.—Santa Monica Bay to San Diego, California (Rathbun).

Remarks.—Commensal in bivalve mollusks: *Pholas, Pachydesma, Modiola* and *Paphia* (Rathbun).

Fabia canfieldi Rathbun

Plate 39, figures 5 and 6

Raphonotus subquadratus Rathbun, H. A. E., 10, 186, 1904 (part: specimen from Monterey).

Fabia canfieldi Rathbun, Bull. U. S. Nat. Mus., 97, 106, text fig. 57, pl. 24, figs. 5 and 7, 1918.

Original Description of Female.—Carapace of unique specimen very soft and so crushed as to be for the most part beyond description. Front devoid of hair and with a short, longitudinal median depression.

Second segment of palp of outer maxilliped very small, shorter, and narrower than first segment, and having the narrow terminal segment attached at about its middle.

As in *F. subquadrata* the palm increases in width to the distal end, the fingers are longer and inclined downward a little, the lower margin of the propodus being more markedly sinuous than in *subquadrata;* fingers not gaping, hairy along inner surface, a prehensile tooth at middle of dactyl and a smaller one at base of propodal finger.

[Ambulatory] legs subcylindrical, naked, relative lengths 2, 3, 1, 4, the second leg on right side one-third longer than on left; first leg stouter than the others; propodites slightly curved, but while having nearly parallel margins they are a trifle stouter at distal end; an exception is that of second right leg, which tapers to distal end; dactyli short, slender, conical, and a little curved up to the hooked, horny tip, except the second of the right side, which is quite straight up to the tip and is also the longest (Rathbun).

Dimensions.—Type, female: "Carapace about 7 mm. wide; approximate length of [ambulatory] legs of second pair, left 8½, right 11 mm." (Rathbun).

Type Locality.—Monterey, California; only a single female specimen known.

Remarks.—Taken from the keyhole limpet, *Lucapina crenulata* (Rathbun).

Genus **Parapinnixa** Holmes

Carapace much broader than long, smooth, and shining; anterior margin nearly straight. Outer maxillipeds with ischium rudimentary, merus large and triangular; palp three-jointed, last joint attached to the tip of the preceding one. First pair of ambulatory legs the largest, the others diminishing successively in length, the last pair being quite small.

Parapinnixa affinis Holmes

Parapinnixa affinis, Holmes, Occas. Papers Calif. Acad. Sci., 7, 95, 1900.

Original Description of Female.—...the carapace is less than twice as wide as long...; the surface of the carapace is smooth and shining and the anterior margin straight. Front triangular, depressed, having a short median groove, Antennules oblique. Buccal area small, triangular, rounded in front, the posterior portion partly covered by a projection of the sternum. Chelipeds stout, smooth; hand thickened, smooth, rounded above and below; dactyl hooked at the tip and armed with a small tooth near the middle of the inner margin, the upper side smooth; pollex [immovable] finger, with two teeth at the tip. First pair of ambulatory legs larger than the others; dactyls short and stout. Next two pairs comparatively slender, having longer dactyls; last pair small, reaching about to the tip of the merus of the preceding pair; dactyls short and stout. Abdomen of the female widest at the third segment, behind which its shape is triangular, the tip broadly rounded (Holmes).

Type Locality.—Deadman Island, San Pedro, California.

Remarks.—This species has not been found since the original specimen was taken and described.

Genus **Pinnixa** White

Carapace much wider than long, more or less membranaceous. Outer maxillipeds with ischium small; merus large, distal portion of outer margin convex; palp three-jointed, jointed to summit of merus; third joint articulated on inner side of preceding one near the base. Third pair of ambulatory legs larger and longer than others, usually considerably so.

Key to the California Species of Pinnixa

I. Dactylus of third ambulatory leg strongly falcate, the corneous tip bent at an angle to the general outline of the segment. Females much larger and softer than the males.

A. Merus of third ambulatory leg of male more than twice as long as wide. Fingers of female not gaping; immovable finger of male horizontal. Carapace oblong, about one and one-half times as wide as long. (Not known south of San Pedro.)

faba, p. 259.

B. Merus of third ambulatory leg of male twice as long as wide. Fingers of female gaping; immovable finger of male deflexed. Carapace pointed at sides, about twice as wide as long.

littoralis, p. 260.

II. Dactylus of third ambulatory leg straight or slightly curved, the corneous tip continuing the general line of the segment.

A. Fourth ambulatory leg when extended not reaching end of merus of third ambulatory leg; third ambulatory leg enormously large in proportion to body. Carapace very wide, nearly three times as wide as long.

1. Chela stout. Propodus of second ambulatory leg wide. (Not known south of Laguna Beach.)

longipes, p. 257.

2. Chela feeble. Propodus of second ambulatory leg narrow.

tubicola, young, p. 265.

B. Fourth ambulatory leg when extended reaching end or beyond end of merus of third leg.

1. Propodus of third ambulatory leg about as wide as long.

a. Carapace of female twice as wide as long. Propodus of last two legs squarish, much wider at distal end than proximal end of dactylus. Male not known. (Not known north of San Clemente Island.)

tomentosa, p. 258.

b. Carapace of female two and one-half times as wide as long; of male twice as wide as long. Propodus of last two legs tapering at distal end almost to width of proximal end of dactylus.

tubicola, p. 265.

2. Propodus of third leg distinctly longer than wide.

a. Carapace very convex, sloping from the middle in all directions; slightly more than one and one-half times as wide as long. Chela with immovable finger, thumb, strap-shaped; hand much widened toward distal end; fingers with wide triangular gape. (Not known north of Venice, California.)

barnharti, p. 261.

b. Carapace more or less flattened, not sloping from the middle in all directions. Immovable finger not strap-shaped but diminishing from base.

i. Chela with immovable finger markedly deflexed. Carapace about twice as wide as long.

occidentalis, p. 262.

ii. Chela with immovable finger not deflexed.

a. Immovable finger straight or nearly so; lower margin of palm not convex. Carapace about twice as wide as long. (Known only from San Francisco Bay.)
franciscana, p. 263.

b. Immovable finger curved upward distally; lower margin of palm convex.

i. Carapace more than twice as wide as long; male not known. (Known only from off Catalina Island.)
hiatus, p. 265.

ii. Carapace less than twice as wide as long.

* Carapace laterally tapering, about one and three-fourths times, more or less, as wide as long. Sides of male abdomen convex. (Not known south of San Francisco Bay.)
schmitti, p. 264.

** Carapace laterally subtruncate; about one and two-thirds times as wide as long. Sides of male abdomen more or less straight, not convex, first segment very wide at base. (Known only from Monterey Bay.)
weymouthi, p. 266.

Pinnixa longipes (Lockington)

Tubicola longipes Lockington, Proc. Calif. Acad. Sci., **7**, 55, 1876 (1877).
Pinnixa longipes Holmes, Proc. Calif. Acad. Sci., (2), **4**, 573, pl. 20, figs. 19–20, 1894 (1895); Occas. Papers Calif. Acad. Sci., **7**, 92, 1900; Rathbun, H. A. E., **10**, 188, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 58, text fig. 6, 1910; Rathbun, Bull. U. S. Nat. Mus., **97**, 137, figs. 80, 81, 1918; Nininger, Jour. Ent. Zool., Pomona Coll., **10**, 41, fig. 31, 1918.

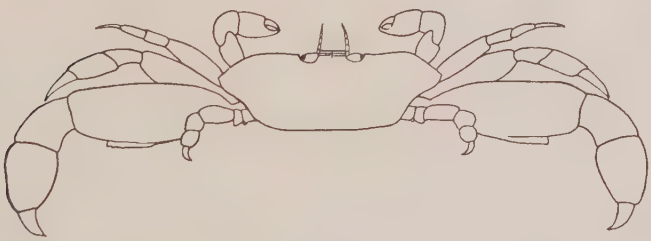


Fig. 152. *Pinnixa longipes* (after Holmes).

Characters.—Carapace considerably more than twice as wide as long, somewhat flattened above, and furnished with a transverse depression behind the gastric area. Chelipeds small, short, hairy; chelae stout, oblong, compressed. First two pairs of ambulatory legs slender, and furnished with slender, nearly straight dactyls which are about equal to the propodi in length; second pair slightly larger than the first; third pair of ambulatory legs enormously developed; merus with a kind of flange on the posterior margin, dactyl stout, somewhat curved, much

shorter than the propodus; last pair of legs small and stout, scarcely reaching beyond middle of merus of preceding pair; dactyl stout, shorter than propodus.

Dimensions.—Type: length of carapace 3.2 mm., width a little less than 6.3 mm., width from claw to claw at fourth pair 19.1 mm.

Type Locality.—Tomales Bay, in tube of annelid.

Distribution.—Tomales Bay to Laguna Beach, California (Rathbun).

Remarks.—The width of *Tubicola longipes* from end to end of the fourth pair of legs is eight [six?] times greater than its length from back to front (Lockington). There is probably no other crab of such great width relatively to its length, there is certainly no known species in which the fourth pair of ambulatory legs is so enormously enlarged, and I believe there is no Brachyuran which exceeds it in diminutiveness; commensal in the tube of an annelid worm, *Clymenella* (Holmes). This very odd looking little crab inhabits the sand tubes of *Clymenella*, which are abundant on the sand bars exposed at low tide near the outlet of Balboa Bay. One or two of the crabs were found in almost every tube examined which contained a worm (Nininger).

Pinnixa tomentosa Lockington

Pinnixa tomentosa Lockington, Proc. Calif. Acad. Sci., 7, 156 (12), 1876 (1877); Holmes, Proc. Calif. Acad. Sci. (2), 4, 568, pl. 20, figs. 11–13, 1894 (1895); Rathbun, Bull. U. S. Nat. Mus., 97, 141, text figs. 85, 86, pl. 30, fig. 8, 1918.

a *b* *c*

Fig. 153. *Pinnixa tomentosa*, ♀, enlarged; *a*, third ambulatory leg; *b*, first ambulatory leg; *c*, chela (after Holmes).

Characters.—Female (from Rathbun): Carapace and legs covered with a short pubescence. Carapace nearly twice as wide as long, smooth, and rounding down to margins; a shallow depression behind gastric region; cardiac region swollen but not ridged. A transverse depression just behind margin of front; antero-lateral margin marked by a granulated line on the branchial region.

Hand oblong, compressed, margins convex, the lower concave near the thumb. Fingers little over half length of palm, toothless; thumb wide, but abruptly narrowed near hooked tip; dactyl curved, subuncinate at apex, no longer than thumb. (Chela after Holmes.)

First [ambulatory] leg much more slender and shorter than second; second leg nearly as long as third and less stout, its propodus tapering distally; first and second dactyls slender, slightly curved, third and fourth dactyls stout, short, and more curved but not hooked; third [ambulatory] leg very wide, merus a little more than one and one-half times as long as wide, propodus nearly square: fourth [ambulatory] leg similar in shape but much smaller.

Dimensions.—Type, female: length of carapace 7.5 mm., width of same 14 mm.

Type Locality.—Angeles Bay, Gulf of California.

Distribution.—San Clemente Island, California, to Angeles Bay, Gulf of California (Rathbun).

Pinnixa faba (Dana)

Plate 40, figures 1, 2, 3, and 4

Pinnotheres faba Dana, Proc. Acad. Nat. Sci. Phila., **5**, 253, 1851; Crust. U. S. Expl. Exped., **1**, 381, 1852, pl. 24, fig. 4, 1855.

Pinnixa faba Holmes, Occas. Papers Calif. Acad. Sci., **7**, 93, 1900; Rathbun, H. A. E., **10**, 188, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 59, text fig. 7, 1910 (part: specimen from Monterey Bay); Rathbun, Bull. U. S. Nat. Mus., **97**, 142, text figs. 27, 88, pl. 31, figs. 1–4, 1918.

a *b*

Fig. 154. *Pinnixa faba*, × 6; *a*, right chela of ♂; *b*, left chela of ♀ (after Rathbun).

Characters.—Carapace about one and a half times as wide as long, oblong, strongly convex, both longitudinally and transversely, truncated at the sides. In some males the anterolateral angle is vertically compressed and correspondingly thin, forming a laterally projecting lobe; no transverse ridge behind the gastric area; anterolateral margins marked by a low ridge, which disappears near the orbits; orbits oval. Hands of chelipeds flattened, widest just behind the articulation of dactyl; more or less pubescent on inner side between the fingers; fingers of female not gaping; immovable finger of male horizontal. Merus of third pair of ambulatory legs of male more than twice as long as wide.

Dimensions.—Type, female: length of carapace 11.7 mm., width 17 mm.

Color.—Dark or light brown, or brownish red, with hand coarsely dotted with color (Dana). Specimens in formalin: General color of females orange rufous with patches of scarlet on the gastric regions. Eggs orange chrome. Male, orange rufous, or dirty greenish-white, with orange rufous spots on carapace and a few of the same on chelipeds and legs. One female from Taylor Bay, British Columbia, was entirely white in life (Rathbun).

Type locality.—Puget Sound.

Distribution.—From Prince of Wales Island, Alaska, to Humboldt Bay, California (Rathbun). San Pedro, California (Holmes).

Remarks.—Commensal in bivalve mollusks: *Schizothaerus, Saxidomus, Mya, Paphia* (Rathbun); and cloaca of large holothurian, *Molpadia* (Holmes). Miss Rathbun, however, thinks Holmes's specimen may have been *P. barnharti.*

Pinnixa littoralis Holmes

Plate 40, figures 5, 6, 7, and 8

Pinnixa littoralis Holmes, Proc. Calif. Acad. Sci., (2), **4**, 571, pl. 20, figs. 14–16, 1894 (1895); Occas. Papers Calif. Acad. Sci., **7**, 91, 1900; Rathbun, H. A. E., **10**, 188, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 58, 1910 (part: except fig. 5 and specimens from Puget Sound); Way, Puget Sd. Mar. Sta. Publ., **1**, 362, fig. 14, 1917; Rathbun, Bull. U. S. Nat. Mus., **97**, 145, text figs. 89, 90, pl. 31, figs. 5–8, 1918; Nininger, Jour. Ent. Zool., Pomona Coll., **10**, 41, fig. 32, 1918.

a *b*

Fig. 155. *Pinnixa littoralis*, × 6; *a*, left chela, ♀; *b*, left chela, ♂ (after Rathbun).

Characters.—Carapace about twice as long as wide, pointed at sides, flattened above; a transverse depression behind the median region followed by a transverse intumescence; orbits pointed at outer angle. Hands of chelipeds compressed, oblong but widening a little distally; fingers of female gaping; immovable finger of male deflexed. Immature females as well as immature males have chelae usually resembling those of adult males, that is, with the fingers widely gaping, thumb short, and dactyl strongly curved. Merus of third pair of ambulatory legs of male twice as long as wide.

Dimensions.—Type, length of carapace 4.5 mm., width 9.5 mm.

Color.—Regarding this species, Miss Rathbun remarks that it

> ... can be distinguished from *P. faba* by the constantly different color. In formalin the carapace and appendages of female have a light greenish yellow ground, with large blotches of coral red on anterior half. Eggs orange-vermilion, sometimes chestnut. First three ambulatory legs with a rufous band which embraces the propodus and part of the carpus. Male light dirty greenish-white, with bands on legs like those of female.
>
> A pair from near the station at Departure Bay [Vancouver Island] are said by Doctor Fraser to be yellow (in place of coral red), with a band of dull salmon on the legs.
>
> Miss Way gives the color as grayish white, often with brownish-tipped walking legs.

Type Locality.—Bodega Bay, California.

Distribution.—Sitka, Alaska, to San Diego, California.

Remarks.—Some of the specimens were found in the holes of the common clam, *Mya*, others were picked up on the shore (Holmes). Of five hundred specimens taken by Fraser, the adults with few exceptions inhabited the giant clam, *Schizothaerus*, while all the young of both sexes were taken from the small clam, *Mya*. Has also been found in *Saxidomus*, *Macoma*, and *Paphia* (Rathbun). The only specimen recorded from Balboa Bay was found clinging to the outside of the slime tube of *Cerianthus* (Nininger).

Biological Survey of San Francisco Bay.—Pinnixa littoralis is represented in the collection by a single immature female specimen taken from a clam dredged at D 5709 (middle bay) in 10 to 12½ fathoms on "muddy sand." For this station the annual mean temperature is 13.05° C with an annual range of 7.8° to 18.0° C; the mean salinity 24.39, range 15.2 to 30.1. One specimen of *Pinnixa franciscana* was also taken at this station.

Pinnixa barnharti Rathbun

Plate 41

Pinnixa tumida Streets, Bull. U. S. Nat. Mus., **7**, 115, 1877; not *P. tumida* Stimpson, 1858.

Pinnixa faba Rathbun, H. A. E., **10**, 188, 1904 (part: specimen from San Pedro).

Pinnixa barnharti Rathbun, Bull. U. S. Nat. Mus., **97**, 149, text fig. 91, pl. 32, 1918.

Original Description of Female.—Carapace hexagonal, very convex in both directions, sides truncate, antero-lateral margin a line of very fine granules not continued to hepatic region, side walls vertical, subhepatic region prominent, surface coarsely punctate toward the sides, furrow behind gastric region shallow, three deep pits on each side anteriorly, posterior margin very concave. Lobes of front prominent and arcuate, viewed from above. Orbits broadly oval, filled by the eyes. Antenna as long as width of front and one orbit.

Chelipeds large; chelae rhomboidal, increasing greatly toward fingers, a sinus in lower margin near base of thumb; thumb subhorizontal, a little curved or convex beneath, of nearly equal width throughout, tip obliquely truncate, lower corner armed with a short, sharp tooth, which is crossed by the sharp tip of the dactylus; dactylus oblique, making a large triangular gape with the thumb; a strong tooth at middle of dactylus, a fringe of hair above; a patch of long hair in the gape.

Merus of cheliped and [ambulatory] legs hairy above; merus and propodus of last two legs hairy below, carpus and propodus of last leg hairy above. [Ambulatory] legs thick, first nearly as long as second, but narrower, second reaching to dactylus of third, fourth to middle of carpus of third; merus of last 3 legs convex above, propodus of all tapering, dactylus short, nearly straight, broad at base, acuminate. (Rathbun.)

Dimensions.—Type, female: length of carapace 10.7 mm.; width 16.2 mm.

Color.—The carapace in alcohol is largely a bluish purple; a few patches of same color on chelipeds and first three legs (Rathbun).

Type Locality.—Venice, California; from cloaca of "sea cucumber" (holothurian).

Distribution.—From Venice, California, to Ballenas Bay, Lower California (Rathbun).

Remarks.—"Chela of male very like that of female except palm a little shorter; in small but mature female, palm is still shorter.... Commensal with holothurians, *Molpadia*" (Rathbun).

Pinnixa occidentalis Rathbun

Plate 42, figures 5 and 6

Pinnixa occidentalis Rathbun, Proc. U. S. Nat. Mus., **16**, 248, 1893 (part: except specimen from San Diego); Holmes, Occas. Papers Calif. Acad. Sci., **7**, 89, 1900; Rathbun, H. A. E., **10**, 187, pl. 7, fig. 4, pl. 9, figs. 6, 6*a*, 1904 (part: except specimens from Cape Fox); Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, text fig. 3, 1910; Rathbun, Bull. U. S. Nat. Mus., **97**, 155, text fig. 96, pl. 34, fig. 1, 1918.

Pinnixa californiensis Rathbun, Proc. U. S. Nat. Mus., **16**, 249, 1893; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 90, 1900; Rathbun, H. A. E., **10**, 187, pl. 7, fig. 3, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 56, 1910 (part: except young female from Pacific Grove).

a *b*

Fig. 156. *Pinnixa occidentalis*, ♂; *a*, dorsal view, × 1⅓; *b*, chela, × 3½ (after Rathbun).

Characters.—Carapace more or less uneven, about twice as wide as long, occasionally a little more or a little less, with a single bilobed cardiac crest, anterolateral margin marked by a sharp, more or less granulated ridge running from the orbit diagonally outward and backward, crossing the hepatic region, and forming the anterolateral margin of the carapace. Chelipeds stout, setose; palm broad, flat, shining on outside, immovable finger short, markedly deflexed, prehensile edge with a stout tooth in the middle and a small one near the tip; movable finger much curved, sometimes with a tooth in the middle. Ambulatory legs setose; first pair shorter than the chelipeds, weak; second pair longer and stronger than the first; third pair very long and strong, especially the merus, propodus longer than wide; fourth pair intermediate in length between the first and second; dactyli as long as the propodi.

Dimensions.—Type, male: length of carapace 9.5 mm., width 19.5 mm.; female: length of carapace 10.5 mm., width 20.5 mm.

Type Locality.—South of Unimak Island, Alaska.

Distribution.—Unalaska to Magdalena Bay, Lower California. Shallow water to 238 fathoms.

Remarks.—Cardiac ridge blunter in female than in male, immovable finger longer, third ambulatory leg shorter and wider, about two and one-half times as long as wide. Specimens vary in the proportion of length to width of carapace, in the prominence of cardiac ridge, in the direction of the margins of the second abdominal segment of the male, in the length of the immovable finger of the male (Rathbun). Commensal in the burrows of the gephyrean worm *Echiurus* (Kincaid, from Rathbun).

Biological Survey of San Francisco Bay.—*Pinnixa occidentalis* was only taken outside the bay at three stations, D 5785, 5788, and 5789,

at depths between 33 and 68 fathoms. The bottom in all three cases was "very fine, green sand." The range of temperature (bottom) 9.3° to 9.8°C; range of salinity, 34.2 to 34.3.

Pinnixa franciscana Rathbun

Plate 42, figures 1, 2, 3, and 4

Pinnixa franciscana Rathbun, Bull. U. S. Nat. Mus., 97, 161, text fig. 100, pl. 35, figs. 1–4, 1918.

Original Description of Female.—Near *P. occidentalis*, but carapace smoother, cardiac ridge blunt and straight. Propodus of cheliped small, upper edge convex, densely granulate, lower margin straight from near the wrist to end of finger; outer surface with a granulate ridge just above lower edge, continued to end of finger and fringed above with hair, also a line of granules through the middle, and two lines of punctae and hairs on upper half. Fingers wide, not gaping, tips crossing, a wide triangular tooth at middle of dactylus, a similar tooth on distal half of fixed finger. First [ambulatory] leg reaches nearly to middle of dactylus of second, second nearly to end of third, fourth to middle of carpus of third; merus of third leg one and two-thirds times as long as wide, distally narrow (Rathbun).

Dimensions.—Type, female: length of carapace 5.7 mm.; width 11 mm.; length of third leg about 12 mm.

Type Locality.—San Francisco Bay, California, 10 to 12½ fathoms ("Albatross" station D 5709).

Distribution.—San Francisco Bay, California (see below, Biological Survey San Francisco Bay).

Remarks.—Male differs from female in sharpness of cardiac ridge. Cardiac ridge in female may be somewhat sharp, as in female, station [D] 5743. The merus of second [ambulatory] leg is very slender in the young female and increases proportionally more rapidly in width than the body in size. Cheliped of male not known (Rathbun).

Biological Survey of San Francisco Bay.—Pinnixa franciscana has been found only in San Francisco Bay, where it was taken at seven of the dredging stations (D 5709, 5715, 5723, 5743, 5772, 5824, 5825), from off Point San Pedro in the upper bay to off the Mission Rock in the lower bay, and ranging from 1¼ to 15½ fathoms in depth (see plate 9). One specimen was taken at all but one station (D 5825), located about halfway between Angel Island and the Southampton Shoal Light, where six were obtained. The bottom in all cases was more or less sandy mud accompanied in at least two cases with numerous worm tubes, the probable habitat of this species. The lowest and highest annual mean temperatures and salinities for the stations at which *P. franciscana* was taken, given here in view of its apparently sedentary habits, range respectively from 12.0° to 13.3° C, and from 24.4 to 31.0.

Pinnixa schmitti Rathbun

Plate 42, figures 7, 8, and 9

Pinnixa occidentalis Rathbun, H. A. E., **10**, 187, 1904 (part: specimens from Cape Fox).

Pinnixa schmitti Rathbun, Bull. U. S. Nat. Mus., **97**, 162, text fig. 101, pl. 35, figs. 6, 7 and 9, 1918.

Fig. 157. *Pinnixa schmitti,* chela, ♂, × 7 (after Rathbun).

Original Description of Female.—Like *franciscana* but carapace more oblong, as sides are less pointed and anterolateral marginate crest is more prominent. Cardiac ridge obsolescent, broad and smoothly rounded; from a point behind each extremity, a smooth ridge curves forward to the anterior branchial angle, widening distally. Palm swollen, upper and lower margins convex, the latter becoming slightly concave under base of finger, which last inclines upward distally; outer and upper surfaces granulate, granules thinnest in middle, forming a line near lower edge, especially of finger, but very different from sharp, raised line in *franciscana,* prehensile edges of fingers meeting, sinuous. Relative lengths of [ambulatory] legs as much as in *franciscana,* but merus of third [ambulatory] leg less dilated, twice as long as wide, margins granulate, as also of the propodus (Rathbun).

Dimensions.—Type, female: length of carapace 5 mm., width 8.5 mm., length of third ambulatory leg about 9.7 mm. A male specimen: length of carapace 5 mm., width 9.2 mm., length of third ambulatory leg about 10 mm.

Type Locality.—San Francisco Bay, California, 9½ to 11 fathoms ("Albatross" station D 5723).

Distribution.—Port Levasheff, Unalaska, Alaska, to San Francisco Bay, California; 7 to 80 fathoms (Rathbun).

Remarks.—In the fully developed male the chela is much higher in proportion to its length than in the female, its margins straighter, surface non-granulate, the thumb very short, the dactylus bent in an obliquely vertical direction, prehensile edges each obscurely bidentate. Abdomen suboblong, its sides slightly convex.

There are males in which the chelae are similar to those of the female, that is, swollen, granulate, thumb only a little shorter than dactylus; they differ from those of the female in being more swollen and dactylus shorter.

There is some variation (1) in the width of the legs, but as they are of the same general shape I am disposed to think that the specimens listed below are all of one species; (2) in the length and prominence of the granulate, anterolateral ridge; (3) in the inequalities of the dorsal surface of the carapace (Rathbun).

Biological Survey of San Francisco Bay.—This species was taken only within the bay at five stations (D 5706, 5715, 5718, 5723, 5825), having approximately the same range as those at which *P. franciscana* was taken: from off Point San Pedro in the upper bay, to off Mission Rock in the lower bay (see plate 9). Although only one specimen was taken at each station, the center of greatest abundance like that

of the preceding species, is about halfway between Angel Island and the Southampton Shoal light, where three of the hauls lie in close proximity to one another (D 5706, 5718, 5825). At one of these (D 5825) as well as at its only upper (D 5715) and lower bay (D 5723) stations, it was taken in company with *P. franciscana* and like it was found on bottom of the same general character; and it apparently has the same habits, for at two of the stations numerous worm tubes were brought up. The annual mean temperature and salinities, which range respectively from 12.7° to 13.3° C, and from 25.3 to 29.6, correspond very closely to those given for *P. franciscana.*

Pinnixa hiatus Rathbun

Plate 43, figures 1, 2, 3, and 4

Pinnixa hiatus Rathbun, Bull. U. S. Nat. Mus., **97**, 164, text fig. 102, pl. 36, figs. 1–4, 1918.

Original Description of Female.—Carapace very wide, narrowed at sides, anterolateral margin arcuate without a definite angle and marked by a raised and finely granulate edge up to hepatic region; posterior margin very long and straight; front advanced, widely emarginate in dorsal view. Surface smooth, sparingly punctate, a groove behind gastric region. Subhepatic region prominent. Orbits oval, filled by eyes.

Palm suboblong, upper margin convex, lower margin of palm and thumb sinuous, a granulated ridge on distal half just above lower edge. A corresponding ridge on dactylus. Thumb definitely shorter than dactylus and curving up toward it, extremity obliquely notched by means of a tuberculiform tooth. Dactylus curved, a tooth just behind middle; a wide gape when fingers are closed.

Merus of first [ambulatory] leg slender, of other legs narrowed at distal end; carpus of all legs longer than propodus; propodus tapering distally, but wider at end than adjoining end of dactyl; dactyls styliform, more slender in first and second pairs; in third pair, the anterior edge of merus and posterior edge of propodus is finely saw-toothed, posterior edge of merus more coarsely granulate, anterior edge of dactylus spinulous. Posterior margin of merus of second leg finely granulate. Posterior margin of third leg and both margins of last leg fringed with hair (Rathbun).

Dimensions.—Type, female: length of carapace 3.6 mm., width 7.7 mm.

Type Locality.—Off Santa Catalina Island, California; 50 fathoms; known only from a single female specimen.

Pinnixa tubicola Holmes

Plate 43, figures 5, 6, 7, and 8

Pinnixa tubicola Holmes, Proc. Calif. Acad. Sci., (2), **4**, 569, pl. 20, figs. 17–18, 1894 (1895); Occas. Papers Calif. Acad. Sci., **7**, 91, 1900; Rathbun, H. A. E., **10**, 187, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 57, text fig. 4, 1910; Way, Puget Sd. Mar. Sta. Publ., **1**, 361, fig. 13, 1917; Rathbun, Bull. U. S. Nat. Mus., **97**, 165, fig. 103, pl. 36, figs. 5–8, 1918.

Characters.—General form subcylindrical. Carapace about two and one-half times as wide as long in the female, and twice as broad as long in the male; a shallow, transverse depression behind the gastric region which is a convex

(not crested) transverse intumescence, from which the carapace curves sharply downward toward the broad, slightly concave posterior margin; outer portion of anterolateral margin defined by a ridge. Chelipeds rather small; hand oblong, longer than the preceding joints combined, fingers hooked at the tips, their inner margins meeting when closed; immovable finger not deflexed, but curved upward distally; lower margin of palm convex. First pair of ambulatory legs slender with slender dactyls about equaling propodi in length; second pair much longer and stouter than first pair with relatively stouter dactyls, slightly shorter than their propodi; third pair stouter and a little longer than the second and furnished with shorter and stouter dactyls, dactyls markedly shorter than propodi, propodi about as long as wide; fourth pair of ambulatory legs similar to but much shorter than third, reaching, however, but not exceeding the end of the merus of the third pair.

Dimensions.—Type: length of carapace 4 mm., width 10 mm.

Color.—Golden brown with spots of bluish gray on dorsal surface; much lighter and of uniform color on ventral surface (Way).

Type Locality.—Trinidad, Cape Mendocino, California.

Distribution.—From Puget Sound to San Diego, California (Rathbun).

Remarks.—In calcareous tube of worm, Trinidad, California (Holmes), and in tubes of *Amphitrite* (Way, from Rathbun).

Pinnixa weymouthi Rathbun

Plate 43, figures 9 and 10

Pinnixa californiensis Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 56, 1910 (part: young female from Pacific Grove).

Pinnixa faba Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 59, fig. 7 (part: not synonymy).

Pinnixa weymouthi Rathbun, Bull. U. S. Nat. Mus., 97, 166, text fig. 104, pl. 36, figs. 9 and 10, 1918.

Original Description of Male.—Carapace smooth; cardiac region a transverse rounded elevation; sides subtruncate, anterolateral angles rather prominent; front deflexed, advanced; anterolateral margin sharp, from hepatic region backward; posterior margin little wider than base of abdomen.

Chelae pubescent; upper and lower margins of manus convex; fingers subconical, horizontal, curving toward each other near tips, edges sinuous, meeting, tips crossing.

[Ambulatory] legs pubescent, especially last two segments, propodi convex on both margins; first leg narrow, propodus no longer than wide, dactylus long and nearly straight; second leg wider, but similar, reaching end of propodus of third leg; third leg wide, dactylus slightly curved; fourth leg similar but smaller, reaching middle of carpus of third.

Abdomen with first segment very wide at base, its sides very oblique; second to sixth segment gradually diminishing, sixth constricted at middle; seventh short, margin broadly rounded (Rathbun).

Description of Female.—The female referred to here is about the same size as the male but has a thin shell, so that its shape is not well defined. Front less advanced and anterolateral margin less sharply marked than in male. Chelae not pubescent outside, similar in shape to those of male, except that the thumb is a little shorter. [Ambulatory] legs are as in male (Rathbun).

Dimensions.—Type, male: length of carapace 3.3 mm.; width 5.3 mm.

Type Locality.—Monterey Bay, California; 5 fathoms.

Distribution.—Monterey Bay, California; beach to 5 fathoms (1 male, off Monterey Wharf, 5 fathoms; 1 ovigerous female, Third Beach, Pacific Grove, free on the beach) (Rathbun).

Remarks.—
Related to *P. tubicola, schmitti,* and *hiatus,* all of which have smooth carapaces, swollen palms, and nearly straight dactyli of the legs; *weymouthi* is narrower, its sides truncated, and antero-lateral angle more prominent. The male abdomen of *tubicola* is more triangular, that of *schmitti* has more convex margins than in *weymouthi* (Rathbun).

Genus **Scleroplax** Rathbun

Carapace transverse, hard. Outer maxillipeds with ischium rudimentary; merus longer than broad, oblique, not curved, winged on the margins; palp three-jointed; last joint articulated near the proximal end of the inner margin of the preceding one. Ambulatory legs similar in character, slender; third pair the longest, but slightly exceeding the others.

Scleroplax granulata Rathbun

Plate 44, figures 1, 2, and 3

Scleroplax granulata Rathbun, Proc. U. S. Nat. Mus., **16,** 251, 1893.
Pinnixa (*Scleroplax*) *granulata* Holmes, Occas. Papers Calif. Acad. Sci., **7,** 94, 1900.
Scleroplax granulata Rathbun, H. A. E., **10,** 188, pl. 7, fig. 5, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 59, text fig. 8, 1910; Way, Puget Sd. Mar. Sta. Publ., **1,** 362, fig. 15, 1917; Rathbun, Bull. U. S. Nat. Mus., **97,** 171, text fig. 109, pl. 37, figs. 1–3, 1918.

Characters.—Carapace subpentagonal, hard, granulate anteriorly and near the margins, punctate elsewhere; a granulated ridge defines the lateral margin; front narrow, produced, slightly convex as seen from above; orbits nearly circular, eye-stalks very short and thick; antennules almost transverse. Ambulatory legs slender, granulate, the third pair longest, the second longer than the first, the first pair weakest; the joints narrow, flattened; the dactyls very slender, almost straight, and equal the propodal joints in length. Abdomen of male narrow, tapering very gradually to the broad terminal segment; third, fourth, and fifth segments partially anchylosed; abdomen of female very smooth and shining, fringed with hair, not reaching beyond the sternum.

Dimensions.—Type, female: length of carapace 6 mm., width 8 mm.
Color.—Grayish white, very much darker after moultings (Way).
Type Locality.—Ensenada, Lower California.
Distribution.—Puget Sound, to Ensenada, Lower California (Rathbun).
Remarks.—Has been taken from the shell of *Mya* (Rathbun).

Biological Survey of San Francisco Bay.—Only one specimen of *Scleroplax granulata* was taken and that in the middle bay (D 5775) in company with *Crago munitella,* in 4 to 7 fathoms. The bottom was composed of "large and small angular rock fragments;" annual mean temperature 12.01° C, range 8.7° to 14.3° C; salinity, mean 31.04, range 26.6 to 33.3.

Genus **Opisthopus** Rathbun

Carapace usually firm and unyielding, smooth, subquadrilateral or suborbicular; regions not defined, lateral margins regularly arcuated. Outer maxillipeds with ischium well developed, merus broad; palp three-jointed, last joint articulated on the inner side of the preceding one. Ambulatory legs subequal in length, joints flattened.

Opisthopus transversus Rathbun

Plate 44, figures 4 and 5

Opisthopus transversus Rathbun, Proc. U. S. Nat. Mus., **16**, 252, 1893; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 97, 1900; Rathbun, H. A. E., **10**, 188, text fig. 95, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 61, text fig. 9, 1910; Rathbun, Bull. U. S. Nat. Mus., **97**, 173, text fig. 110, pl. 37, figs. 4, 5, 1918; Nininger, Jour. Ent. Zool., Pomona Coll., **10**, 36, fig. 8, 1918.

Fig. 158. *Opisthopus transversus*, ♀, dorsal view, × 1⅕ (from Rathbun, U. S. N. M.).

Characters.—Carapace transverse, convex, thin but not soft and yielding; angles rounded; front deflexed, almost straight when seen from above, with a slight median sulcus; antennules well developed, lodged in deep, diagonal fossae. Ambulatory legs similar in character; joints rather broad, except the dactyls, which are curved and small, a little more than half the length of the propodal joints; second pair of legs the longest, fourth pair the shortest, reaching midway of the propodal joint of the preceding pair. Abdomen of male narrow at base, tapering regularly from the third to the terminal joint or telson, which is subquadrilateral; abdomen of female very wide and long, almost covering the maxillipeds. The female may reach maturity while its abdomen is still as narrow as that of the male.

Dimensions.—Type, female: length of carapace 14 mm., width 18 mm.; male: length of carapace 8.5 mm., width 9.8 mm.

Color.—Carapace richly spotted with vermilion to deep red, polished almost to pearly smoothness (Nininger).

Type Locality.—Monterey, California.

Distribution.—Monterey to San Diego, California (Rathbun).

Remarks.—Found in *Lucapina crenulata*, the large keyhole limpet; in siphon of *Pholas*, the rock-boring mollusk; in mantle cavity of the mussel, *Mytilus edulis;* and in the common holothurian, *Stichopus californicus* (Rathbun). Mr. E. P. Chace, of Los Angeles, recently took a female specimen from the gill chamber of a univalve mollusk, *Astrdea undosa*, and numerous others of both sexes from the shells of *Schizothaerus*.

Family Grapsidae

Carapace quadrate, flattened, or moderately convex; lateral margins straight and parallel or slightly arcuate, frequently toothed; front never very narrow, in general decidedly broad; orbits and eye-stalks of moderate size. Antennules folding back transversely or obliquely. Third maxillipeds with more or less of a gape left between them.

Key to the California Genera of the Grapsidae

I. Carapace as long as or longer than broad, suborbicular, smooth. Anterior edges of ambulatory legs with a thick, dense fringe of hair. Pelagic crabs, usually found on floating seaweed in the open ocean.
Planes, p. 272.

II. Carapace considerably broader than long. Anterior edges of ambulatory legs if hairy only sparsely so, never with a dense fringe. Littoral crabs found on mud flats or among rocks along shore.

A. Carapace transversely striated. External maxillipeds with a wide rhomboidal gape between them.

1. Orbits normal, deep, and concave.
Pachygrapsus, p. 269.

2. Orbits not normal, with posterior surface bulging outward, convex instead of concave. (Only one specimen known, from San Diego.)
Grapsodius, p. 276.

B. Carapace more or less smooth. External maxillipeds only moderately gaping.
Hemigrapsus, p. 272.

Genus **Pachygrapsus** Randall

Carapace marked with transverse striae; anterolateral margins entire, or with one or two teeth. Outer maxillipeds with a wide rhomboidal gape between them; merus as broad as or broader than long, distally truncated, and bearing the palp at its summit. Abdomen of male covers the sternum at its base.

Key to the California Species of Pachygrapsus

I. Merus of last pair of ambulatory legs with two or three sharply distinct teeth at posterodistal angle. Frontal (interorbital) margin distinctly sinuous in frontal aspect. Lateral margins of carapace converging posteriorly from the lateral tooth.
transversus, p. 271.

II. Merus of last pair of ambulatory legs with posterodistal angle inconspicuously denticulate or entire. Frontal (interorbital) margin practically straight in frontal aspect. Lateral margins of carapace strongly arcuate.
crassipes, p. 270.

Pachygrapsus crassipes Randall

Plate 45

Pachygrapsus crassipes Randall, Jour. Acad. Nat. Sci. Phila., **8**, 126, pl. 5, fig. 4, 1839; deMan, Notes Leyden Mus., **12**, 86, pl. 5, fig. 11, 1890; Holmes, Occas. Papers Calif. Acad. Sci., **7**, 79, 1900; Rathbun, H. A. E., **10**, 189, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 61, pl. 13, fig. 41, 1910; Baker, Rept. Laguna Mar. Lab., **1**, 102, 1912: Rathbun, Bull. U. S. Nat. Mus., **97**, 241, pl. 59, 1918.

Fig. 159. *Pachygrapsus crassipes* (after deMan).

Characters.—Carapace nearly square, moderately convex; lateral margins strongly arcuate; entire upper surface except cardiac and intestinal regions transversely striated; frontal (interorbital) margin practically straight in frontal aspect; sides with a single tooth behind the prominent postorbital. Outer maxillipeds with merus quite strongly produced at antero-internal angle. Hand of adult male larger than all the preceding joints combined, a raised line usually present on the upper side of the palm and a delicate line on the lower portion of the outer surface. Merus of last pair of ambulatory legs with postero-distal angle entire.

Dimensions.—Type, male: length of carapace about 40.6 mm., width between 43.2 and 45.7 mm. Carapace of Bay specimens ranged from 7 to 38 mm. in width, the greater number measuring about 25 mm. across.

Color.—General color in life a very dark red with a variable amount of whitish color, which is sometimes almost entirely absent and again gives to the whole a light shade. A line of the light color is usually present in front of each of the striae of the carapace, and spots of it in the intestinal and cardiac regions. The ambulatory legs are similar in color to the carapace, the chelipeds are generally tan colored, veined with red. The thin cuticle at the joints is a livid green (Weymouth).

Type Locality.—Sandwich Islands (doubtful).

Distribution.—From Oregon to Gulf of California; Japan; Korea. The locality given by Randall, the Sandwich Islands, is too doubtful to be relied upon (Rathbun).

Remarks.—This is the very abundant shore crab which is so common scuttling over the stones of the higher beach. It sometimes contains a large parasitic isopod in its branchial cavities (Baker).

Biological Survey of San Francisco Bay.—Pachygrapsus crassipes also proved to be a strictly littoral species, apparently less abundant and less widely distributed than *Hemigrapsus nudus*. Seven specimens were collected among the rocks at Point Bonita, and one each, on the Presidio shore, at Sausalito, and on Red Rock.

Pachygrapsus transversus (Gibbes)

Grapsus transversus Gibbes, Proc. Amer. Assoc. Adv. Sci., **3**, 181, 1850.
Goniograpsus innotatus Dana, Crust. U. S. Expl. Exped., pt. 1, p. 345, 1852, pl. 21, fig. 9, 1855.
Pachygrapsus transversus Rathbun, H. A. E., **10**, 189, 1904; Proc. U. S. Nat. Mus., **28**, 548, pl. 46, fig. 3, 1910; Bull. U. S. Nat. Mus., **97**, 244, pl. 61, figs. 2, 3, 1918.

Fig. 160. *Pachygrapsus transversus*, ♂, × 4/5, right cheliped omitted (after Dana).

Characters.—Carapace about one-third broader than long, lateral margins quite strongly convergent posteriorly from the last lateral tooth; upper surface transversely striated, most distinctly so anteriorly, becoming obsolete posteriorly; several of the striae converge toward the lateral tooth on each side; sides with a well marked tooth behind the postorbital; frontal (interorbital) margin distinctly sinuous in frontal aspect. Hands smooth or finely granulate, with a raised, sometimes obsolete line on the upper margin, and another on the outer surface, near the lower edge, running to the tip of the immovable finger. Merus of last pair of ambulatory legs with two or three sharply distinct teeth at the posterodistal angle.

Dimensions.—Length of carapace 15 mm., width 20 mm. (Dana).

Type Locality.—Key West, Florida.

Distribution.—California (Kingsley) to Peru; Galapagos Islands; Oriental region; West Africa; Bermudas; Bahamas and Florida Keys to Rio de Janeiro (Rathbun).

Genus **Planes** Bowdich, Leach

Carapace smooth, convex, subquadrate or more or less suborbicular; with a slight notch or tooth behind the acute orbital angle. Anterior edges of ambulatory legs with a dense fringe of hair. Pelagic crabs, usually found on floating seaweed in the open ocean.

Planes minutus (Linnaeus)

Plate 46

Cancer minutus Linnaeus, Syst. Nat., ed. 10, **1**, 625, 1758.

Planes minutus Rathbun, H. A. E., **10**, 189, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 63, pl. 14, fig. 44, 1910; Rathbun, Bull. U. S. Nat. Mus., **97**, 253, pl. 63, 1918.

Characters.—Carapace as long as or longer than broad, suborbicular, practically smooth, a few faint lines toward anterior and lateral portions of carapace; the single blunt tooth behind the postorbital sometimes obsolete. Hand with several oblique lines above and below, and a somewhat obscure longitudinal line on the lower portion of the palm running out on the immovable finger. Anterior edges of ambulatory legs with a dense fringe of hair.

Dimensions.—Two specimens from off Point Loma, collected by the "Albatross," measure, male: length of carapace 15 mm., width 14 mm.; female: length of carapace 20 mm., width 19 mm.

Color.—Color varies from light cream with pinkish tinge and light brown mottled to a very dark nut-brown, occasionally with a bluish cast on carapace and yellowish legs, sometimes with whitish blotches and markings on upper surface. (Murray and Hjort, 1912, pl. 6.)

Type Locality.—"In Pelagi Fuco natante" (Linnaeus).

Distribution.—Temperate and tropical seas. Taken at sea, west of Humboldt Bay, in Avalon Bay, Santa Catalina Island, and off Point Loma and San Diego, California (Rathbun). During the month of August, 1918, two small specimens, averaging about a half inch in width, were picked up from the beach at the Scripps Institution, La Jolla, California, by Messrs. P. L. Barnhart and H. J. Snook.

Genus **Hemigrapsus** Dana

Carapace not markedly striated; with two teeth behind the orbital angle. Outer maxillipeds without a wide rhomboidal gape, only moderately gaping; merus large and not produced at the antero-external angle; palp joined in a notch at about the middle of the distal margin. Abdomen of male does not cover the sternum at its base.

Key to the California Species of Hemigrapsus

I. Ambulatory legs hairy. Front with a deep sinus in the middle. Hands of chelipeds not spotted with red.
oregonensis, p. 274.

II. Ambulatory legs smooth. Front arcuate, very slightly sinuous. Hands of chelipeds spotted with red.
nudus, p. 273.

Hemigrapsus nudus (Dana)

Plate 47

Pseudograpsus nudus Dana, Proc. Acad. Nat. Sci. Phila., **5**, 249, 1851; Crust. U. S. Expl. Exped., **1**, 335, 1852, pl. 20, fig. 7, 1855.

Heterograpsus nudus Rathbun, R., The Fisheries and Fishery Industries of the U. S., sec. 1, p. 765, 1884.

Brachynotus nudus Holmes, Occas. Papers Calif. Acad. Sci., **7**, 81, 1900.

Hemigrapsus nudus Rathbun, H. A. E., **10**, 189, 1904; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 62, pl. 14, fig. 42, 1910; Rathbun, Bull. U. S. Nat. Mus., **97**, 267, pl. 69, 1918.

Fig. 161. *Hemigrapsus nudus*, × ⅘ (after Dana).

Characters.—Carapace posteriorly flat, smooth, and punctate, anteriorly convex, undulated, and furnished with small, scattered granules; front arcuate, very slightly sinuous (front bilobed, median emargination shallow but comparatively broad). Chelipeds smooth, mottled above with small, round, red spots; in the adult male there is a rounded lobe on the antero-internal angle of the merus, and a patch of long hair on the inner surface of the hand. Ambulatory legs naked, rather short; dactyls short, stout, scabrous, those of last pair less than two and one-half times, often less than twice as long as wide, and up-turned at the tip.

Dimensions.—Type, female: length of carapace 22.3 mm., width 26.5 mm.; male: length of carapace 22.6 mm., width 26.1 mm. Width of carapace of the Bay specimens ranged from 9 to 39 mm., the greater number being about 25 mm. wide.

Color.—Quite variable. It is generally of a mahogany red, but may be a purplish tone, dark red, or red marbled with white. I have seen some specimens with the upper side almost entirely white (Holmes). Ambulatory legs similar to carapace; chelipeds lighter, marked with numerous small spots of darker red (Weymouth). But amid all the variations of color the red spots on the chelipeds remain an absolutely constant character so far as I can determine. Young specimens present greater color variation than older ones (Holmes).

Type Locality.—Puget Sound.

Distribution.—From Sitka, Alaska, to Gulf of California (Rathbun).

Biological Survey of San Francisco Bay.—Hemigrapsus nudus is a strictly littoral species, recorded only from the middle bay, doubtless because all shore collecting was confined to that section. Specimens from one to a dozen or more were obtained at Point Bonita, along the Presidio shore, at Sausalito, north of the Key Route pier, on Red Rock, and in tide pools along the Richmond shore, north of the Standard Oil pier.

Hemigrapsus oregonensis (Dana)

Plate 48

Pseudograpsus oregonensis Dana, Proc. Acad. Nat. Sci. Phila., **5**, 248, 1851; Crust. U. S. Expl. Exped., **1**, 334, 1852, pl. 20, fig. 6, 1855.

Heterograpsus nudus Rathbun, R., The Fisheries and Fishery Industries of the U. S., sec. 1, p. 765, 1884.

Brachynotus oregonensis Holmes, Occas. Papers Calif. Acad. Sci., **7**, 82, 1900.

Hemigrapsus oregonensis Rathbun, H. A. E., **10**, 189, 1900; Weymouth, Stanford Univ. Publ., Univ. Ser., no. 4, 63, pl. 14, fig. 43, 1910; Rathbun, Bull. U. S. Nat. Mus., **97**, 270, pl. 70, 1918.

Fig. 162. *Hemigrapsus oregonensis,* outline of front, × 4/5 (after Dana).

Characters.—Carapace more strongly undulated in front than in *H. nudus,* but not so much flattened behind; posterior portion not punctate, and anterior portion may be sparsely granulate; front with a deep sinus in the middle, front four-lobed, the median lobes the most prominent. Chelipeds smooth, not spotted with red; in the adult male there is a rounded lobe on the antero-internal angle of the merus, and a patch of long hair on the inner surface of the hand. Ambulatory legs hairy; dactyls narrower than in *H. nudus,* those of the last pair upturned.

Dimensions.—Type: length of carapace 21.2 mm., width 24.4 mm. The Bay specimens ranged from 3 to 29 mm. in width of carapace, the greater number being about 20 mm. wide.

Color.—In life a light grey, with minute blackish or dark blue spots, which are more numerous in some regions than in others. Legs lighter, marked with similar spots; hands of chelipeds whitish in tone, without spots (Weymouth).

Type Locality.—Puget Sound.

Distribution.—From Prince William Sound, Alaska, to Gulf of California (Rathbun).

Remarks.—This species may be readily distinguished from the preceding by its dull color, hairiness of the legs, the four-lobed front, and absence of round red spots on the chelipeds so characteristic of that closely related species (Holmes).

Biological Survey of San Francisco Bay.—Regarding the occurrence of this species Dr. Rathbun (1884, p. 765) says, "*H. oregonensis* is especially abundant in muddy sloughs of salt or brackish water where it literally swarms. Hundreds of uplifted threatening claws welcome the intruder who ventures near the mud flats when the tide is out."

In view of these remarks our shore collections, which were confined to the middle bay, constitute a very imperfect littoral distribution picture. Four specimens were taken among the rocks at Point Bonita between tide marks, thirty at Sausalito, one at Tiburon in a 150-foot seine, twelve from the piles of the Key Route pier, eighty-three on the mud flats north of the Key Route pier, thirty-four along the Richmond shore north of the Standard Oil pier, and twenty-five among rocks on Red Rock.

However, when the dredging records are consulted we find that *Hemigrapsus oregonensis* was taken very much more frequently in the lower than in the other divisions of the bay (see plate 10). It is in the lower bay that the muddy bottom preferred by this species predominates. Here it was taken at sixteen stations (80%), of which the greater number, eleven, were recorded as more or less shelly as they were principally in oyster-beds; but it must be remembered that in the lower bay these shelly bottoms are primarily mud bottoms (Townsend, 1893, p. 348, 350). The other five stations from the lower bay were on a pure mud bottom in three cases, on muddy sand in another, and on an uncharacterized bottom at the remaining one.

In the upper bay this species was taken at but two (10.4%) of the stations, both of which (D 5817, 5819) were made with the sledge trawl off Point Pinole on a somewhat gritty mud bottom; for the middle bay we likewise have only two records (10%), dredged in-shore with the launch off Point San Quentin on an uncharacterized bottom (D 5750), and along the south side of Golden Gate, inside of Fort Point (D 5778), on a bottom largely made up of "fine, clean, gray sand and medium sized rounded stones."

The average number of specimens per haul in the lower bay was sixteen and eight-tenths as compared with one and five-tenths specimens per haul for the upper and middle bays. The greatest number of specimens taken at any station was one hundred and two dredged in 1¼ to 3½ fathoms (D 5768) off Alameda, in the upper part of the lower bay. Seven (35%) of the total number of dredging stations made in the bay were in less than 2 fathoms of water, only five (25%)

exceeded 5 fathoms, while the remaining eight (40%) were of intermediate depth. One specimen was secured while making hydrographic observations in the No. 2 Dumbarton oyster bed (H 5256).

The extremes of temperature and salinity for this species as observed at the hydrographic stations, correlated with the dredging stations from which it was obtained are, respectively, 11.0° to 16.6° C, and 17.5 to 31.6.

A complete list of stations includes: D 5730, 5750, 5766–5768, 5778, 5781, 5782, 5784, 5803, 5810–5814, 5817, 5819, 5847, 5848, 5849; H 5256; Sausalito, Jan. 18, Feb. 14 and 17, Mar. 14, 1913; Point Bonita, Aug. 1, 1912; Key Route pier, piles, Aug. 2, 1912; north of Key Route pier, Aug. 2, 1912; Red Rock, Aug. 3, 1912; Richmond shore, Standard Oil pier, Aug. 3, 1912; Tiburon, Apr. 29, 1913.

Genus **Grapsodius** Holmes

Carapace striated above, with the sides converging behind, and armed with a single tooth behind the postorbital. Front broad, not deflexed, but with the median portion depressed. Eye-peduncles short. Orbits with the posterior surface bulging outwards instead of concave. Maxillipeds narrow, widely gaping, and devoid of an oblique piliferous ridge; merus subcordate, shorter than the ischium, the antero-internal angle produced; palp joined near the middle of the distal margin of the merus. Dactyls spinulous. Abdomen of the male seven-jointed.

Grapsodius eximius Holmes

Grapsodius eximius Holmes, Occas. Papers Calif. Acad. Sci., 7, 84, 1900.

Original Description.—Carapace undulated in front and flattened behind, where it is more strongly striated; sides strongly converging posteriorly. The front is over one-half the width of the carapace and has the outer angles more or less projecting and rounded; the anterior edge is thin and minutely granulated; viewed from above it is nearly straight, being slightly convex on either side of the middle where it is a little concave; viewed from in front it sags downward in the center. The orbits are remarkable in being swollen outward so that there is no hollow receptacle, as is usually the case, for the reception of the eyes; the superior orbital margin is marked by a fine ridge extending from the outer side of the front to the postorbital tooth; the inferior orbital margin is marked by a line of granules extending from the lower side of the postorbital tooth to the buccal area. Maxillipeds slender and wide apart. The ischium is much longer than the merus but not so wide; merus with the outer margin convex and the antero-external angle broadly rounded; the inner margin is straight and the antero-internal angle is produced into a prominent narrow lobe; first joint of the palp strongly convex near the middle of the inner margin; exognath at the base about one-half as wide as the ischium and tapering regularly to the tip which reaches slightly beyond the middle of the merus. Chelipeds subequal; merus short, trigonal, the outer surface transversely striated, the inner margin produced into a laminate expansion which is distally truncated and dentate; carpus with a spine near the middle of the upper margin; hands smooth

and inflated; the upper margin of the palm is broadly rounded, but bears a fine ridge; a very fine ridge on the lower side of the outer surface extending upon the pollex; fingers subcylindrical, not ridged or grooved, and armed within with small teeth. Merus of the ambulatory legs dilated and compressed much as in *Pachygrapsus crassipes*, with the upper margins acute and ending in a tooth a little behind the supero-distal angle; the infero-distal angle, in all but the last pair, is dentate; carpal joints with a few small spines near the distal end of the upper margin; propodi with the sides strongly convex and the upper and lower margins spiny; dactyls rather narrow, shorter than the propodi, strongly spinose above and below, and terminating in slender claws. The abdomen in the male is widest at the third segment, behind which it tapers to the tip, the sides converging more rapidly towards the posterior end; first segment much longer than the second; third segment about as long as the fourth, the sides strongly convex; fifth segment scarcely longer than the fourth and shorter than the sixth; last segment triangular, acute (Holmes).

Type Locality.—San Diego, California.

Remarks.—This species is described from a single dried and somewhat imperfect specimen contained in the Museum of the University of California. The form and arrangement of the antennae and antennules could not be determined nor could I make out whether or not the inferior orbital lobe was in contact with the front. The front, legs, maxillipeds, and striations on the carapace are similar to those of *Pachygrapsus*, but the character of the orbits separates it from that genus as well as all the other genera of the Grapsidae (Holmes).

This species has not been found since original specimen was taken and described. No measurements were given.

Family Ocypodidae

Carapace square or rounded, more or less convex; lateral margins generally without teeth; front moderately or very narrow, more or less depressed or bent downward; orbits transversely lengthened, eye-stalks usually very long. Third maxillipeds almost or quite close the mouth.

Key to the California Genera of the Ocypodidae

I. Eye-stalks moderately stout; corneae elongate, subterminal, eye-stalk projecting beyond them in a short process. Chelipeds in male subequal; fingers with truncate ends. (Only California record, a doubtful one, is from San Francisco Bay.)
Ocypode, p. 277.

II. Eye-stalks slender; corneae terminal. Chelipeds in male extremely unequal; fingers with pointed tips. *Uca*, p. 278.

Genus **Ocypode** Fabricius

Carapace squarish; antennules folded longitudinally. Eye-stalks large, moderately stout; cornea large, covering much of lower surface of eye-stalk, usually subterminal and reaching toward base of eye-stalk. No flagellum on exopodite of outer maxilliped. Chelipeds well developed, unequal but not noticeably different on either side or in either sex.

Ocypode gaudichaudii Milne Edwards and Lucas

Plate 38, figures 5 and 6

Ocypoda gaudichaudii Milne Edwards and Lucas, *in* D'Orbigny's Voy. dans l'Amér. Mér., 6, pt. 1, p. 26, 1843, pl. 11, figs. 4–4*b*, 1847.

Ocypode gaudichaudii Rathbun, H. A. E., 10, 190, 1904; Proc. U. S. Nat. Mus., 38, 550, pl. 43, fig. 2, 1910; Bull. U. S. Nat. Mus., 97, 373, pl. 63, 1918.

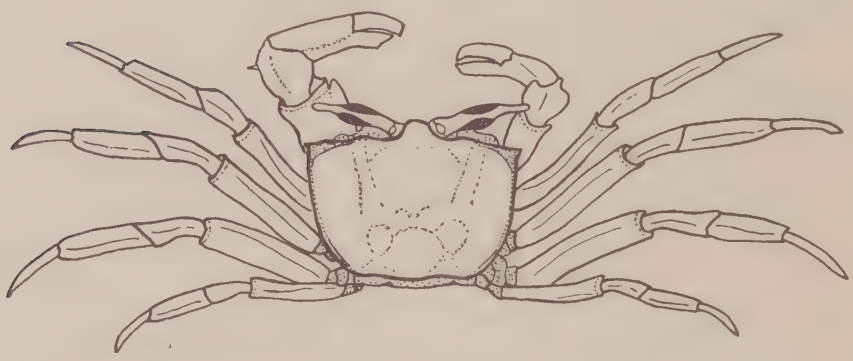


Fig. 163. *Ocypode gaudichaudii*, × 4/5 (from Milne Edwards and Lucas, after Rathbun).

Characters.—Carapace squarish, broader than long, anterior corners flattened; front between the eyes narrow, bent down. Eye-stalks large, elongated, prolonged beyond the corneae in a slender style. Chelipeds stout, somewhat unequal, rough; fingers with truncate ends. Ambulatory legs long, finely roughened.

Dimensions.—Of specimens from Peru, examined by Miss Rathbun: width about 40 mm.

Type Locality.—Chile.

Distribution.—From Lower California to Chile; Galapagos Islands; Honolulu. Three young specimens from San Pablo, California, are in the Museum of Comparative Zoology; determined by Dr. Faxon (Rathbun). In view of the tropical distribution of this species, it is very probable that the label on this lot is either incorrect or the result of an exchange.

Genus **Uca** Leach

Carapace transverse-quadrate; antennules folded longitudinally. Eye-stalks long and slender; cornea short, terminal, confined to distal end of eye-stalk. Exopodite of outer maxillipeds with flagellum. Chelipeds of male strikingly unequal, hand of larger one very large, fingers longer than the palm, hand of smaller feeble; both chelipeds in female feeble.

KEY TO THE CALIFORNIA SPECIES OF UCA

I. Carapace very convex, semi-cylindrical. Male with an oblique stridulating ridge near proximal lower corner of inner surface of large hand; abdomen of male with third to sixth segments fused.

musica, p. 280.

II. Carapace moderately convex, not semi-cylindrical. Male without stridulating apparatus; abdomen of male, inclusive of telson, seven-jointed. (Not known north of False Bay.)

crenulata, p. 279.

Uca crenulata (Lockington)

Plate 49

Gelasimus crenulatus Lockington, Proc. Calif. Acad. Sci., **7**, 149, 1876 (1877).

Gelasimus gracilis Rathbun, Proc. U. S. Nat. Mus., **16**, 244, 1893.

Uca crenulata Holmes, Occas. Papers Calif. Acad. Sci., **7**, 75, pl. 1, figs. 7–9, 1900; Rathbun, H. A. E., **10**, 190, 1904; Rathbun, Bull. U. S. Nat. Mus., **97**, 409, pl. 146, 1918.

a *b*

Fig. 164. *Uca crenulata; a*, carapace; *b*, inner side of large hand (after Holmes).

Characters.—Carapace smooth, moderately convex; lateral margins nearly parallel for a short distance behind the prominent, somewhat forwardly directed, acute anterolateral angles, then converging; front nearly one-third the width of the carapace. Hand of large cheliped of male finely granulated on outer surface, inner surface with an oblique granulated or tuberculated ridge which makes an obtuse angled turn in running from the lower to the upper margin. Ambulatory legs pubescent; merus transversely rugose. Abdomen of male, inclusive of telson, seven-jointed.

Dimensions.—Length 10 mm., width 15 mm. (Rathbun).

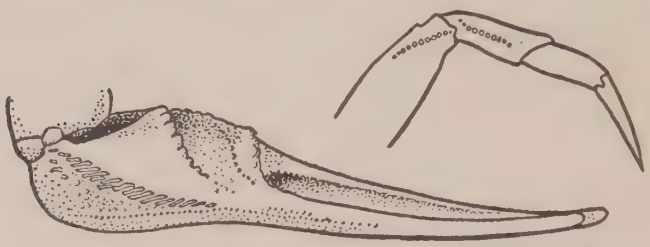
Type Locality.—Todos Santos Bay, near San Diego, California.

Distribution.—From False Bay, San Diego County, California, to Gulf of California (Rathbun).

Uca musica Rathbun

Plate 50

Uca musica Rathbun, Proc. U. S. Nat. Mus., 47, 127, text fig. 5, pl. 10, 1914; Bull. U. S. Nat. Mus., 97, 417, text fig. 171, pl. 154, 1918.



a *b*

Fig. 165. *Uca musica*, ♂, × 3⅓; *a*, lower view of large (left) chela, showing stridulating ridge; *b*, anterior (lower) view of portion of first left ambulatory leg, showing granules which play against stridulating ridge (after Rathbun).

Characters.—Carapace smooth, strongly convex, subcylindrical; anterolateral angles subrectangular; front less than one-fourth the width of the carapace. Hand of large cheliped granulated; with a very prominent ridge across inner surface of palm, bent at an obtuse and rounded angle, and armed for nearly its whole length with a row of large tubercles. Near the proximal lower corner of the inner surface is a longitudinally oblique stridulating ridge, extending from the articulation with the carpus to the lower marginal line of the palm almost below the angle of the transverse ridge. The stridulating ridge is made up of closely placed parallel lines, oblique to the axis of the ridge and subparallel to the lower margin of the palm. When the cheliped is flexed the ridge plays against a line of granules on the lower or anterior surface of the first ambulatory leg; this line extends nearly the whole length of the carpal segment and part way along the merus. Abdomen of male with third to sixth segments fused.

Dimensions.—Type, male: length of carapace 8 mm., width 12.9 mm.

Color.—Prevailing tint of carapace and limbs (in spirit) blue, of varying intensity, shading in parts into greenish and on the fingers of the chelipeds into white (Lockington, from Rathbun).

Type Locality.—Pichilinque Bay, Gulf of California.

Distribution.—Vancouver Island, British Columbia, to Guaymas, Mexico (Rathbun).

IV. DISTRIBUTION

Geographical.[1]—Of the one hundred and eighty-one marine decapods known to occur within the 100 fathom line off the coast of California, forty-two (23%) are found on the west coast of North America only within that area, fifty-nine (33%) range from California northward, fifty-three (29%) range southward, and twenty-seven (15%) range both north and south.

The species confined to California waters on the North American coast are:

Palaemonetes hiltoni†
Pontonia californiensis†
Pandalus gurneyi
Hippolysmata californica†
Spirontocaris affinis°
Spirontocaris lagunae†
Spirontocaris franciscana
Spirontocaris carinata
Spirontocaris picta
Crangon barbara†
Crangon equidactylus
Betaeus harfordi
Betaeus longidactylus†
Nectocrangon californiensis†
Axiopsis spinulicauda°
Callianassa affinis†
Paguristes parvus†
Holopagurus pilosus
Pagurus samuelis
Pachycheles holosericus
Petrolisthes rathbunae†
Cyclodorippe plana
*Loxorhynchus grandis**
*Loxorhynchus crispatus**
Cycloxanthops rugosus†
Lophopanopeus frontalis†
Lophopanopeus heathii
Lophopanopeus leucomanus
Lophopanopeus diegensis
Xanthias latimanus†
Speocarcinus californiensis†
Pinnotheres nudus°
Pinnotheres holmesi°
Fabia lowei†
Fabia canfieldi°
Parapinnixa affinis†
Pinnixa longipes
Pinnixa franciscana°
Pinnixa hiatus†
Pinnixa weymouthi°
Opisthopus transversus
Grapsodius eximius†

Except *Pagurus samuelis*, all of the above are peculiar to California.

More than one-half, thirty-three (56%), of the fifty-nine species ranging northward find their northern limits along the Alaska coast,

[1] As noted in the Introduction this discussion deals only with the littoral fauna. The forms which have been included and which possibly do not properly belong here are the seven cited as "pelagic" or "with a bathymetric range of more than 500 fathoms," (p. 285) all or in part.

The species taken in connection with the Biological Survey of San Francisco Bay are printed in **bold face** type; those reported from the region covered by the survey but not taken during it are marked with an *; those found only north of Point Conception are indicated by a °; and those found only south of that point on the west coast of America are marked with a †. The species lacking either of these last two signs naturally range both north and south of Point Conception.

The northern limits of seven species are somewhat doubtful, but owing to the fact that they are so few in number (4%) and in order to avoid unnecessary

at or south of the Aleutian Islands; only nine (15%), *Spirontocaris prionota,*° *S. flexa,*°* **Crago communis,** *Haplogaster grebnitzkii,*° *Pagurus beringanus,*° **P. hirsutiusculus, Oregonia gracilis,**° *Chionoecetes tanneri,** *Telmessus cheiragonus,*° go beyond into the Bering Sea, while none of the remaining seventeen (29%) are known to occur north of British Columbia, in fact, the ranges of six of these, *Spirontocaris decora, S. kincaidi,* **Crago munitella,** *Callianassa gigas,*°* *Pachycheles pubescens,*°* *Pinnixa tubicola,* end in Puget Sound or the Straits of San Juan de Fuca. Another, **Crago spinosissima,** does not go north of Oregon, and only ten, *Spirontocaris layi,*° **S. paludicola, Crago alaskensis elongata, C. alba,** *Lopholithodes foraminatus,** **Paguristes turgidus,** *Pagurus hemphillii,*° **Pylopagurus minimus,** *Pugettia richii, Pinnotheres concharum,* run up into British Columbia. The thirty-three species ranging northward, whose northern limits are found along the Alaskan coast, at or south of the Aleutian Islands, are:

Pandalus jordani
*Pandalus platyceros**
Pandalus danae°
Hippolytę californiensis
Spirontocaris lamellicornis°
*Spirontocaris bispinosa**
Spirontocaris gracilis
Spirontocaris brevirostris°
Spirontocaris cristata
Crago stylirostris
Crago franciscorum
Crago acclivis
Crago munita
Paracrangon echinata
*Callianassa californiensis**
Pagurus ochotensis
Parapagurus mertensii
Hapalogaster cavicauda
Oedignathus inermis°
Acantholithodes hispidus°
Phyllolithodes papillosus°
Cryptolithodes typicus°
Cryptolithodes sitchensis°
Lopholithodes mandtii°*
Rhinolithodes wosnessenskii°
Munida quadrispina
*Pugettia gracilis**
*Chorilia longipes**
*Scyra acutifrons**
Fabia subquadrata
Pinnixa littoralis
Pinnixa faba
Pinnixa schmitti°

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explanations, they have, for the purposes of discussion, been accepted as unquestioned. These seven species with their ranges, including both doubtful and present known northern limits (in parentheses), are:

Pagurus californiensis, Monterey Bay? (Santa Catalina Island)–Gulf of California.
Panulirus interruptus, Monterey Bay? (San Luis Obispo)–Rosalia Bay, Lower California.
Cyclodorippe plana, Monterey Bay? (San Pedro Bay)–Santa Catalina Island.
Anasimus spinosus, Monterey Bay? (San Pedro Bay)–Cerros Island, Lower California.
Epialtus bituberculatus, Monterey Bay? (Laguna Beach)–Chile.
Portunus xantusii, Puget Sound? (Santa Monica Bay)–Chile.
*Ocypode gaudichaudii**, San Francisco Bay? (Lower California)–Chile.

Three new species, *Dardanus jordani, Pylopagurus holmesi,* and *Homola faxoni,* have been added to this paper since this section on "Distribution" was written. Had they been included here the total number of species of littoral record would have been one hundred and eighty-four.

Similarly, more than half of the twenty-seven "north and south" species, fourteen (52%), also find their northern limits along the Alaska coast from the Aleutians southward; none reach the Bering Sea, the above nine forms ranging northward being the only (5%) California species recorded so far north; of the other thirteen (48%) north and south forms, seven, **Crago nigricauda, Callianassa longimana, Petrolisthes cinctipes,** *P. eriomerus,** **Epialtus productus, Cancer antennarius,** *Uca musica,* reach British Columbia; three, *Spirontocaris snyderi, Portunus xantusii,* **Scleroplax granulata,** reach Puget Sound; one, *Munidopsis quadrata,* the coast of Washington; and two, **Emerita analoga, Pachygrapsus crassipes,** only go as far as the Oregon coast. The fourteen species reaching the Alaska coast but not found north of the Aleutians are:

Pasiphaea pacifica	**Cancer magister**
Upogebia pugettensis	**Cancer gracilis**
Pagurus granosimanus	*Cancer oregonensis**
*Pachycheles rudis**	*Lophopanopeus bellus*
Mimulus foliatus	**Pinnixa occidentalis**
Cancer productus	**Hemigrapsus nudus**
Cancer gibbosulus	**Hemigrapsus oregonensis**

The southern limits of eighteen (67%) of the twenty-seven north and south species are found along the Lower California coast either at Magdalena Bay or at points intermediate between it and Todos Santos Bay; only nine (33%) range south of Magdalena Bay; six, *Pasiphaea pacifica,* **Petrolisthes cinctipes, Pachygrapsus crassipes, Hemigrapsus nudus, H. oregonensis,** *Uca musica,* into the Gulf of California; one, *Mimulus foliatus,* to Mazatlan; one, *Munidopsis quadrata,* in deep water to off the Tres Marias Islands, Mexico; and one, *Portunus xantusii,* to Chile. The eighteen north and south species not recorded south of Magdalena Bay are:

Spirontocaris snyderi	**Cancer productus**
Crago nigricauda	**Cancer antennarius**
Upogebia pugettensis	**Cancer gibbosulus**
Callianassa longimana	**Cancer magister**
Pagurus granosimanus	**Cancer gracilis**
Emerita analoga	*Cancer oregonensis**
*Pachycheles rudis**	*Lophopanopeus bellus*
*Petrolisthes eriomerus**	**Pinnixa occidentalis**
Epialtus productus	**Scleroplax granulata**

Of the fifty-three species ranging southward from California, twenty-three (43%) have not been recorded south of the Coronados-Magdalena Bay stretch, while thirty (57%) run farther south; sixteen, *Palaemon ritteri,*† *Urocaris infraspinis,*† *Periclimenes tenuipes,*†

Synalpheus lockingtoni,† **Paguristes bakeri,** *Pagurus californiensis, Lepidopa myops*† (only to Cape St. Lucas); *Petrolisthes gracilis, Podochela hemphillii, Pelia clausa,*† *Cancer amphioetus,*† *Callinectes bellicosus,*† *Lophopanopeus lockingtoni,*† *Pilumnus spinohirsutus,*† *Pinnixa tomentosa, Uca crenulata,*† run to the Gulf of California; two, *Pleuroncodes planipes, Herbstia parvifrons,* to off the west coast of Mexico; two, *Processa canaliculata,*† *Inachoides tuberculatus,* to Panama; three, *Peneus brevirostris,** *Dromidia larraburei, Pachygrapsus transversus,*† to Peru; five, *Crangon bellimanus, Mursia gaudichaudii,** *Epialtus bituberculatus, Heteractea lunata,*† *Ocypode gaudichaudii,** to Chile; and one, *Munidopsis aspera*†, in deep water to the Straits of Magellan and also in the Atlantic off Brazil; still another, *Planes minutus,* is cosmopolitan, pelagic in temperate and tropical seas The twenty-three species ranging southward not found south of the Coronados-Magdalena Bay stretch, include:

*Spirontocaris palpator**
Spirontocaris taylori
*Crangon dentipes**
Crangon californiensis†
Crago nigromaculata
Crago holmesi†
Crago resima
Panulirus interruptus
Paguristes ulreyi
Galathea californiensis†
*Blepharipoda occidentalis**
*Heterocrypta occidentalis**
Randallia ornata
Randallia bulligera†
Anasimus spinosus
Epialtus nuttallii†
Pugettia dalli†
Pelia tumida†
Cancer anthonyi†
Cancer jordani
Cycloxanthops novemdentatus
Xanthias taylori
Pinnixa barnharti†

Seventeen (9%) of all the above species have also been reported from the western north Pacific, chiefly from Japan and Kamchatka as follows:

*Pandalus platyceros**	Japan
Spirontocaris prionota°	Japan
Processa canaliculata†	Japan; Amboina (also Europe, Madeira, Bermudas, North Carolina to Trinidad, Gulf of Mexico, West Indies).
Crago nigricauda	Japan
Crago communis	Kamchatka
Paracrangon echinata	Japan
Pagurus ochotensis	Japan; Okhotsk Sea
Pagurus hirsutiusculus	Japan; Kamchatka; Siberia
Pagurus samuelis	Japan
Parapagurus mertensii	Kamchatka
Oedignathus inermis°	Japan
Pachycheles pubescens°	Japan
Oregonia gracilis°	Japan

Cancer amphioetus†	Japan; Korea
Cancer gibbosulus	Japan
Telmessus cheiragonus°	Kamchatka; Siberia; Kurile Islands
Pachygrapsus crassipes	Japan; Korea

Only four (2%) species, one of which has already been listed as occurring in Japanese waters, are also recorded from the Atlantic littoral regions, principally from the Bermudas, West Indies and the Gulf of Mexico:

*Crangon dentipes**	Bermudas, West Indies, Key West, Mediterranean, Cape Verde Islands.
Processa canaliculata†	North Carolina to Trinidad, Bermudas, West Indies, Gulf of Mexico; Europe (also Japan and Amboina).
Epialtus bituberculatus	Bermudas; Indian River, Florida, to Brazil (also Chile).
Pachygrapsus transversus†	Bermudas; Bahamas and Florida Keys to Rio de Janeiro, Brazil; West Africa (also Oriental region and Galapagos Islands).

Of these the second and fourth are cosmopolitan with respect to their distribution.

Two species are pelagic, *Pleuroncodes planipes* and *Planes minutus*. The first is known only from the Pacific shores of America ranging "90 miles S.W. of San Francisco to 150 miles S.W. of Cape St. Lucas"; while the second is a more or less cosmopolitan form found in temperate and tropical seas throughout the world. The latter might properly be included in both the preceding lists.

Five (3%) species have a bathymetric range exceeding 500 fathoms, and even two of these have been taken in over 1000 fathoms, as follows:

Munida quadrispina°	50– 559 fathoms
Munidopsis quadrata	47– 859 fathoms
Munidopsis aspera†	69–1500 fathoms
*Chorilia longipes**	27– 603 fathoms
Chionoecetes tanneri°*	29-1625 fathoms

All of these are confined to the Pacific except *Munidopsis aspera*, which has also been taken in the Atlantic off Brazil (type locality) and which, except for its strictly abyssal record there, 1500 fathoms, might well be included among the Atlantic forms above. It can, however, be called a cosmopolitan form for all primary abyssal forms as a rule are cosmopolitan, or would prove to be more or less so were the deep sea thoroughly explored.

Summarized, the foregoing gives:

Species peculiar to California	41 (23%)
Species which on the west coast of North America are confined to California waters	42 (23%)
Species found in California and the region north of it	101 (55%)
Species found in California and the region south of it	95 (52%)
Species common to California and the regions both north and south	27 (15%)
Species finding the northern limit of their range in the Bering Sea	9 (5%)
Species finding the northern limit of their range in the Aleutian-Southeastern Alaska stretch	47 (27%)
Species finding the northern limit of their range in the British Columbia-Oregon stretch	40 (22%)
Species finding the southern limit of their range in the Coronados-Magdalena Bay stretch	41 (23%)
Species finding the southern limit of their range in the Gulf of California or beyond	39 (21%)
Species found at Panama or farther south	12 (7%)
Species occurring only in the stretch between the Aleutian Islands and Magdalena Bay	133 (73%)
Species also reported from the western north Pacific, chiefly from Japan	17 (9%)
Species also reported from the eastern littoral Atlantic	4 (2%)
Cosmopolitan species	4 (2%)
Pelagic species	2 (1%)
Species having a bathymetric range exceeding 500 fathoms	5 (3%)

The California littoral decapod fauna is almost wholly confined to the west coast of North America; in fact, forty-one (23%) of the forms represented in it are peculiar to California waters alone. Exclusive of cosmopolitan and near cosmopolitan species only sixteen (9%) have been reported from the western North Pacific, chiefly from Japan, and only twelve (7%) from as far south as Panama or farther. If we consider *Crangon dentipes,* which occurs also in the Mediterranean and the Cape Verde Islands, as near cosmopolitan, only one non-cosmopolitan California species is common to the Atlantic littoral, viz., *Epialtus bituberculatus.*

That nearly three-fourths (73%) of the species systematically treated in this paper, range, on the west coast of America, only within the stretch lying between the Aleutian Islands and Magdalena Bay seems indicative of the existence of a more or less uniform and continuous faunal area of like extent,[2] within which these species are so

[2] North of California there are (based on Rathbun, 1904*a*, pp. 6, 7, and accompanying table) but seventy-seven species occurring within the 100 fathom line which have not been reported from California. Of these twenty (26%) do not range north of the Aleutians, being confined to the stretch lying between those islands and the coast of Oregon; fifty-seven (74%), however, find their northern limits either in the waters of Arctic Alaska or the Bering Sea. But of the latter

distributed as to preclude subdivision into smaller regions or districts (cf. appendix I, p. 310).

Arguing from the distribution of the hydroids of the west coast of North America, Dr. C. McLean Fraser asserts (1911, p. 6) that, "The more the group is studied and the greater the number of locations for examination included, the more reason there is for believing that there are no sudden, nor comparatively sudden breaks in distribution along the entire West Coast, though naturally certain species disappear and others as gradually come in."

In an earlier paper on the same group of organisms (hydroids) Dr. Torrey noticed (1902, pp. 6, 7) that "from Alaska Peninsula to San Diego there are no abrupt transitions in the fauna." Although thinking "it possible, for purposes of comparison, to divide this great region into four subregions," viz., (1) Alaska Peninsula to Sitka, (2) Puget Sound, Vancouver Island and vicinity, (3) San Francisco Bay and vicinity, including Monterey Bay, (4) Southern California, south of Point Conception, he expressed the feeling, later justified by Dr. Fraser, that, "future exploration will doubtless reduce these differences."

In a recent monograph on the shallow water starfishes of the north Pacific coast from the Arctic Ocean to California, Professor A. E.

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very few are to be found south of the Aleutians in less than 100 fathoms; only seven range as far south as Puget Sound, although some "are often found out of their normal region in the cold glacier-fed bays and sounds of southeastern Alaska."

Unalaska is probably the western limit of the faunal region suggested, as approximately 20% of the northwardly ranging California and 40% of the "north of California" decapods occurring in the Aleutian-Oregon stretch, find there their northern limit.

South of California comparatively little is known of the Lower Californian and Gulf of California faunae other than what has been listed in this paper, or in Miss Rathbun's "Descriptions of New Genera and Species of Crabs from the West Coast of North America" (1893); "Brachyura of the 'Albatross' Voyage, 1887–1888" (1898), and "Stalk-eyed Crustacea of Peru" (1910). An approximate tabulation of Miss Rathbun's lists gives a total of one hundred and twenty-four species from the Gulf of California and the west coast of Lower California. Irrespective of their southern ranges, forty-three species are not found north of the Gulf; thirty are reported from Cape St. Lucas; and twenty-five reach Magdalena Bay; only fifteen go beyond, of which only four are found north of Abreojos Point, two at San Bartolomé (or Turtle) Bay, and two off Cerros Island. The eleven unaccounted for bear the indefinite locality label "Lower California." Miss Rathbun, in her Peruvian lists, so designated twenty-six species, but reference to original sources reduced that number to eleven.

The papers of Faxon (1895) and Bouvier (1895*a* and 1898) were consulted, but barring species already cited practically none of Faxon's come within the 100 fathom limit, while Bouvier described about fifteen new species, all of which seem to be confined to the Gulf of California.

The fauna of the Gulf of California is largely peculiar to it alone, and is more related to that of the Panama region than to any further north.

Verrill (1914, p. 18) undertakes to divide the region with which we are here concerned into three "faunal districts":

> "*The Columbia-Alaskan,*" including "the coasts and islands of Alaska, south of the Aleutian Islands, and the entire coast of British Columbia, with Vancouver Island; Puget Sound, and the northwestern coast of Washington; the Gulf of Georgia; and the Straits of Fuca"; "*The Californian,*" including "the middle and southern parts of the coast of Washington; all of the Oregon coast; and the coast of California to Point Conception, or the north end of the Santa Barbara Channel"; and "*The South Californian,*" including "the coast of southern California, from the Santa Barbara Channel, Santa Rosa Island, and Santa Cruz Island to the middle part of the Lower California coast."

His districts, however, in the light of the remarks he makes concerning them, do not seem to be very well founded and can without difficulty be merged into the one large area of which they are but arbitrary subdivisions. For example, regarding his *Columbia-Alaskan* and *Californian* faunae he says (1914, p. 348):

> The former includes a total of eighty-five species and named varieties; the latter includes forty altogether. *For my present purpose these may best be considered collectively, as they have many species in common.*[3] The two lists include ninety-nine species, subspecies and varieties. Of these, only sixteen species and varieties are not known to occur in the Columbia-Alaskan fauna, while twenty-four are common to both. Of the ninety-nine forms, only eight are of Arctic origin . . . leaving nine[ty]-one that may be considered as characteristic of the region.

And, with respect to the *South California* fauna (1894, pp. 345 and 349):

> So far as known, this fauna has few species peculiar to it. The species are largely members of the more northern faunae that extend far south, and partly species of the more southern fauna of Lower California and the Gulf of California that range northward beyond the normal limits of that fauna. . . . The list given . . . includes twenty-nine species and varieties. Of these, *twenty-two occur farther north.*[3] Of the remaining six species, three are known to occur in the Panamic fauna, and probably find here their northern limits. . . . The remaining three, at present, seem to belong particularly to this fauna. . . . This faunal district, as now known, does not show any special peculiarities of its own. It is a meeting ground, so to speak, between the Panamic and Californian faunae.

According to Dr. Wesley R. Coe, the "Nemerteans of the Pacific Coast" (1910, p. 118), also exhibit considerable continuity in their distribution. Of the thirty-two species enumerated from Alaska nearly one half, fourteen, "were found also on the California coast during a single summer.

Eleven of these forms, which are common both to the California coast and to Alaska, were found at Monterey Bay, ten at San Pedro or in the deep water in the vicinity, while only two were collected at

[3] Italics inserted by the author.

San Diego, and these two were both common to the other two localities. At San Diego, however, the opportunities for collecting were comparatively limited, and but a short time was spent at that place."

That neither Fraser, Torrey, nor Coe considered the region south of San Diego, and that thirty-three of the California decapods at present find the southern limit of their range at San Diego is no doubt due to the extreme dearth of material from the west coast of Lower California. Except for the explorations of the elder Anthony (A. W.) and a number of scattered stations of the "Albatross" the littoral portion of this region remains today almost as much a "terra incognita" as it was before the expeditions of the California Academy of Sciences to Magdalena Bay and the "Cape." It still offers an extremely fertile field for the ambitious collector.

But Dr. A. E. Ortmann (1896*a*) was the first to point out the continuity of the faunal region under discussion, with whose "Pacific Boreal (Littoral) Subregion," lying south of the Aleutian Islands it closely corresponds.

Unlike almost all other students of zoogeography who seem to have followed the inductive method and constructed their zoogeographical divisions according to the actual distribution of animals, Dr. Ortmann followed the deductive method and constructed his divisions according to the differences in the physical conditions influencing the distribution of animals. Of these "probably no single factor is a more effective barrier to the extensive geographical range of marine animals than is that of temperature" (Mayer, 1914, p. 3), for, to use the words of Doflein (1904, p. 269), "Alle Erfahrungen der letzten Zeit haben uns mehr und mehr gelehrt, dass die Verbreitung der Meerestiere am meisten von den Wassertemperaturen beeinflusst wird."

Torrey, Coe, and Verrill all realized the importance of the influence of temperature on the distribution of the forms upon which their studies were based.

Though Dr. Torrey spoke of his faunal differences as being correlated with certain geographical differences, he said (1902, p. 7):

> North of the [Alaska] peninsula is a region whose waters are largely covered with ice for more than half of each year. South of the peninsula begins a vast stretch of coast which is washed by the comparatively warm waters of the Japan Current. This current is probably accountable for the absence of abrupt transitions between the faunal area which I have tried to schematize above [quoted on p. 287 of this paper], and the exceedingly long distances to which some of the northern species have been distributed southward. The temperature of the current varies gradually with latitude, however, and that offers some explanation for the small faunal differences that exist.

Coe said (1910, p. 118):

> There can be no doubt that future collections will add materially to the number of... [nemerteans], whose range extends at least as far southward as Monterey Bay or even to Point Conception. And while this is a considerable range geographically, yet the environmental conditions of marine forms are not greatly different between Monterey Bay, Puget Sound, Sitka and the Eastern Aleutian Islands. The temperature of the water is but a few degrees different and in some seasons of the year is actually warmer on the coast in portions of Alaska than it is in Puget Sound, or even in the deeper water off the California coast.

Furthermore, although his faunal districts do not seem to have been founded on any such basis, Verrill said of his west coast starfishes (1914, p. 19):

> The limits of distribution on that coast seem to be determined entirely by the temperature of the water, especially in the breeding season, due probably to the greater sensitiveness of the free-swimming larval forms. The adults can regulate their temperatures by migrating into deeper or shallower water as occasions require.

As Ortmann anticipated, and Torrey and Coe more or less successfully demonstrated, there exists a comparative uniformity of temperature along a considerable part of the west coast, which permits the great latitudinal and intricately overlapping distribution of the marine organisms with which we are here concerned, and which is necessary to the establishment of our faunal area.

North of California to the Aleutians is a vast stretch of coast which with the exception of isolated glacier fed bays is warmed much above the temperature normal to such latitudes by the Kuro Siwo, the Japan current. This strikes the American coast in the neighborhood of Sitka where it separates into two streams, a northern, running up into the Gulf of Alaska and thence southeastward along the Alaska Peninsula into the eastern Aleutians, and a southern one which "broadens out and drifts slowly toward the equator, curving away from the coast."

South of Puget Sound to about Magdalena Bay is a region of almost equal extent which is cooled by an upwelling of cold abyssal water to a degree considerably below the normal expectation for its latitude.[4] The surface water along this section of the coast also exhibits a southward drift, and though it is known as the California

[4] "Between the latitudes 45° ... and 25° ... the mean annual surface temperature is progressively lower as the coast is approached. This fall in mean annual temperature is clearly indicated at every depth from 250 fathoms up to the surface, where there is an inshore temperature averaging 5° less than that found 1,000 miles off-shore.... The [appended] tables show that the off-shore surface temperatures at latitude 30° are much below the normal (the temperature given in the first column), while those at latitude 40° are somewhat greater, at least in

Current "it really is the part of the Japan Stream bordering the Pacific Coast, and doubtless would not have been given a different name were it not for its low temperature and relatively greater velocity." (McEwen, 1915, p. 133.)

It is these two great, as it were compensating influences, the one warming a northern, normally cold region, and the other cooling a southern, normally warm region, which tend to equalize the temperatures along the greater part of the west coast and to make possible the large faunal area which extends from about the eastern Aleutian Islands to near Magdalena Bay, Lower California.

These conditions are graphically portrayed, in a general way, in Berghaus's *Physical Atlas* (1892, pls. 21 and 22, "Seeströmungen"), but our present detailed knowledge concerning them is almost entirely due to the researches conducted by Dr. G. F. McEwen under the auspices of the Scripps Institution (1910, 1912, 1915, 1916).

A number of students of the west coast fauna, chiefly conchologists (Dall, 1899, 1909, 1916, and Bartsch, 1912, also Torrey and Verrill above), attach great importance to Point Conception as a faunal barrier. Possibly their conclusions are influenced by a predominance of littoral (*sensu strictu*), or shallow-water forms. These, especially in the case of mollusks, always reflect extremely localized environments, and were they excluded and only those of less restricted (bathymetric) range considered, i.e., 25 to 50 to 100 fathoms, no doubt Point Conception as an apparent faunal barrier would cease to be significant. Of the California decapods, only twenty-eight (15%) are at present restricted to the region north of Point Conception and

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winter. Also, it appears that the annual range of off-shore temperatures agrees with the normal range for the same latitude. But the inshore temperatures are notably less than the others for the same latitude, especially during the warmest part of the year, and consequently have less than the annual normal range. Again, the maximum and minimum temperatures occur in-shore some months after the corresponding normal times; and the variation of in-shore temperatures with respect to the latitude is scarcely half the normal amount." (McEwen, 1915, p. 134.)

Surface Temperatures at Latitude 30, 150 Miles South of San Diego

	Average ocean temperatures for the whole circle having the given latitude.		Temperature of the Pacific at the boundary of the California and Japan currents.		Temperature of the inshore water along the Pacific coast.	
	Temp.	Time of occurrence	Temp.	Time of occurrence	Temp.	Time of occurrence
Maximum	77°	August	72°	Aug., Sept.	65°	September
Minimum	64°	February	61°	April	59°	May
Annual range	13°		11°		6°	

Surface Temperatures at Latitude 40°, off Cape Mendocino

Maximum	66°	August	66°	September	57°	October
Minimum	48°	February	51°	April	52°	March
Annual range	18°		15°		5°	

forty-three (23%) to the region south of it, while one hundred and ten (61%) range both north and south.

Biological Survey of San Francisco Bay.—Geographically the species taken in connection with the survey (**bold face** type in the preceding lists) fit very well into the scheme outlined above. This also holds true if the species reported from the region covered by the survey (the bay and that portion of the Gulf of the Farallones lying south of the Farallon Islands) but not taken in course of it (marked with an * in the preceding lists) are included, as shown in the following summary:

Summary of Geographical Distribution of the Biological Survey Species[5]

	Only, = 46	Plus those reported from region but not taken during Survey, = 70
Species peculiar to San Francisco Bay (*Pinnixa franciscana*)	1 (2%)	1 (1%)
Species which on west coast of North America are confined to California waters	4 (9%)	6 (8%)
Species ranging north of survey region	40 (87%)	57 (81%)
Species ranging south of survey region	42 (91%)	65 (93%)
Species ranging both north and south	37 (80%)	53 (76%)
Species finding the northern limit of their range in the Bering Sea	3 (6%)	5 (7%)
Species finding the northern limit of their range in the Aleutian-S.E. Alaska stretch	19 (41%)	28 (40%)
Species finding the northern limit of their range in the British Columbia-Oregon stretch	15 (33%)	19 (27%)
Species finding the southern limit of their range in the Coronados-Magdalena Bay stretch	15 (33%)	22 (31%)
Species finding the southern limit of their range in the Gulf of California or beyond	5 (11%)	8 (11%)
Species occurring only in the stretch between the Aleutian Islands and Magdalena Bay	38 (83%)	57 (81%)
Species also reported from the western North Pacific chiefly from Japan	8 (17%)	9 (13%)
Species also reported from the Atlantic littoral (*Crangon dentipes*)		1 (1%)
Species having a bathymetric range exceeding 500 fathoms		2 (3%)

Ecologically only the species taken in the course of the survey operations will be considered, and then only in a very general way. Future collecting will unquestionably considerably alter the local distribution patterns, as at present known, for a number of the species; for aside from the fact that only forty-six[5] (66%) of the total seventy

[5] Through an unfortunate oversight *Cancer gibbosulus* was omitted from this discussion. Of this species three specimens were taken, outside, at station D 5790, 33 to 35 fathoms, bottom "very coarse variegated sand, with a small proportion of fine sand."

species known or reported from the region investigated were found, all shore collecting, including seine hauls, was unfortunately confined to the middle bay. No doubt many, if not all the forms so taken are to be found along the ocean beaches outside. At least one of the dredged species, *Pandalus danae,* is known to be plentiful outside though taken by us only in the bay. Moreover, nearly a fourth, eleven (24%), of the species were taken but once during the survey:

Crago resima
Crago alba
Crago communis
Pagurus samuelis
Pylopagurus minimus
Holopagurus pilosus
Acantholithodes hispidus
Randallia ornata
Oregonia gracilis
Pinnixa littoralis
Scleroplax granulata

Those taken at more than ten stations are in no greater number, comprising, likewise, less than a fourth (24%) of the species. Only the first five of these were obtained from about one fourth of the total number of dredging stations. Arranged in order of the number of stations, dredging and hydrographic, at which each was taken, they are as follows:

	Number of stations		
	D.	H.	Total
Crago franciscorum	94	137	231
Crago nigricauda	103	69	172
Spirontocaris cristata	35	28	63
Cancer magister	57	1	58
Crago stylirostris	40	3	43
Hemigrapsus oregonensis	19	1	20
Crago nigromaculata	19	....	19
Callianassa longimana	16	2	18
Cancer productus	16	....	16
Cancer gracilis	14	....	14
Pagurus hirsutiusculus	13	....	13

However, with respect to their local distribution the survey species belong to three groups: (1) those taken only outside; (2) those taken only in the bay; and (3) those taken both in the bay and outside.

1. The species taken only outside are sixteen (35%) in number, as follows:

Pandalus jordani
Spirontocaris gracilis
Crago alaskensis elongata
Crago communis
Crago alba
Crago resima
Crago spinosissima
Paguristes turgidus
Paguristes bakeri
Holopagurus pilosus
Pagurus ochotensis
Pylopagurus minimus
Acantholithodes hispidus
Randallia ornata
Oregonia gracilis
Pinnixa occidentalis

All these are bottom dwellers, and almost without exception all returns for each were from depths of about 30 fathoms or more. Of the species taken at the regular series of stations, specimens of three only were found in shoaler water; *Crago alaskensis elongata* at one of eight stations, in 19 to 26 fathoms (D 5792); *Paguristes turgidus* at one of three stations, in 13 to 14 fathoms (D 5806); and *Pagurus ochotensis* at two of eight stations, corresponding one with each of the preceding. On the other hand, all but two, *Crago alba* and *Pylopagurus minimus,* each of which was taken but once in 33 to 35 fathoms at the same station (D 5790), ranged into 40 or more fathoms of water. Seven, *Pandalus jordani, Crago alaskensis elongata, C. communis, C. resima, C. spinosissima, Paguristes turgidus* and *Pinnixa occidentalis,* were even taken in 60 to 68 fathoms in the deepest haul made (D 5788). Of these the first and second were also found at each of the other six outside stations lying beyond the 30 fathom line, the second, in addition, as mentioned above, being also obtained from one station inside that line; the third and fourth species were only taken at the deepest station, and the fifth only at the deepest station and one other; the last two were taken at three stations each. The only species recorded from more than one outside station and not taken at the deepest is *Pagurus ochotensis.*

In nearly every case the bottom was composed of fine, more or less greenish sand, which at one station (D 5791) was marked by "refuse and garbage" and at only one other (D 5790) replaced by a "very coarse variegated sand, with a small proportion of fine sand." At this last, of the six species recorded from it, *Pandalus jordani, Crago alaskensis elongata, C. alba, Pagurus ochotensis, Pylopagurus minimus* and *Paguristes bakeri,* two, the third and fifth, were not found elsewhere.

So far as shown by the hydrographic observations made outside, none of the outside species was obtained from water having a salinity less than 33.9 (bottom reading, D 5790); the highest salinity recorded was 34.3 (bottom, D 5789). The corresponding (bottom) temperatures ranged from 9.3° (D 5788) to 11.1° C (D 5806).

Owing to the lack of any very definite data regarding their occurrence *Acantholithodes hispidus, Randallia ornata,* and *Oregonia gracilis* are not included in the above discussion.

2. Of the twenty-three (50%) species taken only in the bay, seven are represented only in the shore collections, and for reasons already given will here be considered apart. Two of these seven are

burrowing forms, which, though not found in company, were taken only from sandy beaches:

Emerita analoga was dug out of the beach skirting the Presidio, west of Fort Point, and brought up in the seine both at Fort Baker and on Angel Island.

Upogebia pugettensis was obtained both at Sausalito and at Tiburon; at the latter place by means of the seine.

The other five are all primarily inhabitants of rocky beaches:

Oedignathus inermis, at Point Bonita.

Petrolisthes cinctipes, at Sausalito, and along the Richmond shore.

Pagurus samuelis, along the Richmond shore.

Pachygrapsus crassipes, on the Presidio shore near Fort Point, at Point Bonita, at Sausalito, and on Red Rock.

Hemigrapsus nudus, on the Presidio shore near Fort Point, at Point Bonita, at Sausalito, north of the Key Route Pier, along the Richmond shore, and on Red Rock.

The other sixteen bay species grouped on the basis of their distribution within the bay, arrange themselves as follows:

a. Ten, restricted to the middle bay:

Pandalus danae
Spirontocaris franciscana
Spirontocaris paludicola
Spirontocaris brevirostris
Spirontocaris taylori
Crago munitella
Epialtus productus
Cancer antennarius
Pinnixa littoralis
Scleroplax granulata

b. One, found only in the middle and the lower bay.

Cancer productus.

c. Five, common to all three divisions of the bay:

Callianassa longimana
Pagurus hirsutiusculus
Pinnixa franciscana
Pinnixa schmitti
Hemigrapsus oregonensis

a. Excepting the first, third and ninth, seven of the ten species found only in the middle bay, inclusive of shore stations, are restricted wholly to that portion lying west of a line drawn across the head of Raccoon Strait, and from Blunt Point on Angel Island to the nearest point on the San Francisco shore.

This limitation of range seems to be closely correlated with the character of the bottom, which within that area is more or less hard, rocky, gravelly, or sandy with very little if any admixture of mud, exclusive, of course, of the muddy portion of Richardson Bay, where only two hauls of the boat dredge were made and none of the strictly middle bay species was found.

In addition to being found only on a rocky substratum, *Epialtus productus* was always in patches of kelp, or in their immediate vicinity: at Point Bonita, Sausalito, and east of Fort Point. *Spirontocaris taylori,* another "hard bottom" species, was also taken only at localities characterized by an abundant growth of algae along both shores of Golden Gate and in bunches of seaweed stripped from the piles of the Sausalito Ferry building. So far as our observations go, the only other middle bay species, excepting *Spirontocaris paludicola* mentioned below, the distribution of which may be similarly conditioned, is *Spirontocaris brevirostris,* for although taken near the head of Raccoon Strait on a bottom characterized simply as "stones," it was also taken at the south side of Golden Gate in company with *Spirontocaris taylori.*

Though no doubt exercising a considerable influence on the distribution of the bay species, the effect of temperature and salinity on these bottom dwelling forms is much more difficult of demonstration and probably less important, at least within this section, than that exerted by the character of bottom. Of the species found exclusively in the bay only three were taken with the tow-net, *Callianassa longimana, Cancer antennarius* and *Hemigrapsus oregonensis,* respectively two, three, and one specimen each, the latter obviously an accident.

Of the three middle bay species, *Pandalus danae, Spirontocaris paludicola,* and *Pinnixa littoralis,* not wholly restricted to the portion lying west of the line drawn above, the third was found only in the predominantly muddy eastern portion of the middle bay; the first, *Pandalus danae,* was returned but once from a "variegated mud ... sand and fine gravel" bottom in this eastern portion, as compared with thirty-two specimens from a principally coarse sand gravel and stone bottom in the western portion of the middle bay; while the second, *Spirontocaris paludicola,* was taken but twice in the middle bay, once in its western portion, in the eel grass along the northern shore of Angel Island, and once in its eastern portion, from the algal growth in tide pools north of the Standard Oil pier, Richmond.

b. In lacking a straining apparatus "for removing fine particles of foreign matter from its respiratory stream of water," *Cancer productus* is ill adapted for life on more or less muddy or purely sand bottoms, and although recorded from the lower bay and the easterly sections of the middle bay, it was taken most frequently and abundantly in the western middle bay, as is to be expected. Here

twenty-two specimens were taken at ten stations, all on primarily gravel or rock bottoms, as compared with twelve at seven stations in the easterly parts of the middle and lower bay, of which several had more or less hard bottoms, composed largely of shells, shell fragments, or clinkers. Aside from the scarcity of favorable bottom, it is possible that the great fluctuations of salinity obtaining in the upper bay may tend to exclude *Cancer productus* from that division.

c. As the bottom of the greater part of the bay is predominantly muddy, it is to be expected that the five bay species listed as occurring in all three divisions will show some preference for bottoms of that character.

Callianassa longimana in view of its burrowing habits would naturally be restricted to the softer bottoms, and it is not surprising that no specimens of this species were taken in the western middle bay. In the eastern middle bay it was dredged at nine stations, in the lower bay at five, and in the upper at three.

Pagurus hirsutiusculus, although only taken in the course of shore collecting, from rocky shores around the middle bay, was dredged from more or less shelly bottoms in the predominantly muddy sections of the bay; once in the upper bay, four times in the lower bay and seven in the eastern middle bay. Of the other six stations at which this species was taken four were on the more or less hard sandy or rocky bottom of the western middle bay, and two in the eel grass patches around Angel Island, one in the western, the other in the eastern middle bay.

Pinnixa franciscana and *P. schmitti* have practically the same range within the bay, in fact, coincide at three stations. In nearly every case the bottom from which they were dredged was a more or less sandy mud, accompanied in at least two instances by numerous worm tubes, the probable habitat of both species. With the exception of one specimen of *P. franciscana* taken from a bottom of "soft mud, with numerous worm tubes," off Belvedere Point, in Richardson Bay, neither species was found in the western middle bay.

Hemigrapsus oregonensis, as is well known, shows a marked preference for muddy bottoms, being especially abundant on mud flats at low tide though taken at times in more or less rocky situations in company with *Hemigrapsus nudus.* In the predominantly muddy lower bay an average of sixteen and eight-tenths specimens per haul was taken at each of sixteen stations, while in the middle and upper bay only one and five-tenths specimens were returned from each of the two hauls made in both of those divisions.

3. Seven (15%) of the survey species were found both in the bay and outside:

Spirontocaris cristata
Crago nigricauda
Crago nigromaculata
Crago stylirostris
Crago franciscorum
Cancer magister
Cancer gracilis

These seven are really bay species which range outside as far as the environmental conditions correspond in general to those obtaining in the portions of the bay in which they range inside. With the exception of *Spirontocaris cristata* and *Cancer gracilis* none of these species was taken outside the 30 fathom line, nor, so far as our records indicate, in water of (bottom) salinity exceeding 34.0. Comprising, on the other hand, nearly two-thirds (63%) of the eleven species taken at more than ten stations, and all of the five taken at about one-fourth of the dredging stations, they should be, and in fact are, fairly well distributed throughout the bay. *Crago nigromaculata* is the only one of them failing of record in the upper bay.

Spirontocaris cristata was taken only three times outside, two specimens at each of two stations, and one at a third, in 8½ to 9 fathoms (bottom not characterized), in 9½ to 11¾ fathoms (bottom, "coarse sand and gravel"), and 29 to 36 fathoms (bottom, "refuse and garbage"). In the upper bay, however, *Spirontocaris cristata* was taken at two stations (1 D and 1 H), in the middle bay at thirty-three (21 D and 12 H), and in the lower bay at twenty-five (10 D and 15 H). The lower bay with its predominantly muddy bottom seemed to be the more favored habitat of this species. Here fourteen and four-tenths specimens per dredge haul were returned as compared with two and two-tenths for the middle bay and two for the upper bay. The average per catch with tow-net was, lower bay, four and eight-tenths, middle bay, three and five-tenths, and upper bay, one.

Cancer gracilis, the only other species found in the bay which ranged beyond the 30 fathom line was taken but twice outside, one specimen in 8 to 9 fathoms, on a bottom of "fine, dark, very clean sand," and two specimens in 39 to 40 fathoms, on "very fine dark-green sand." Although taken in the bay at but one upper, eight middle and three lower bay stations, its distribution was very closely related to that of the preceding species, *Spirontocaris cristata*, coinciding with it at five of the stations from which it was recorded and very nearly at the other nine. Similarly, too, the greater number of specimens per haul was in favor of the stations made on more or less muddy bottoms.

Crago nigromaculata though lacking in the upper bay, in common with other fairly well distributed bay species, seemed to a certain extent also to prefer more or less muddy bottoms. Of the nineteen stations returning it only two were located on the harder bottom of the western middle bay, and only three on sandy bottoms outside.

Crago stylirostris, however, although exceeding the range of *Crago nigromaculata* both within and outside the bay, in direct contrast to that species was found most frequently as well as most abundantly on more or less hard, sand or sandy bottoms. In the western middle bay *Crago stylirostris* was taken at twenty-eight dredging stations, in the eastern middle bay at seven, and in the upper and lower bay at only two each. Outside it was returned at eight stations from fine, grey, or coarse sand and pebble bottom. At the more or less muddy eastern middle, upper, and lower bay stations less than eleven specimens per haul were obtained, with one exception at which thirty-three were taken. But of the outside and western middle bay stations thirty returned more than twelve specimens each; of these eight returned more than thirty-three, and five more than fifty specimens. Only three specimens were taken in the tow-net, one at each of three hydrographic stations, one middle, and two lower bay.

Crago nigricauda and *Crago franciscorum* are the two most widely distributed decapods in the bay and outside within the 30 fathom line. Both were taken abundantly in all three divisions of the bay, and the latter was also abundant outside. More or less muddy bottoms returned the greater number of specimens per haul, though otherwise their distribution seemed little affected by the character of the bottom. Of the two *Crago nigricauda* is apparently more of a "bottom dweller," for even though taken at seven more dredging stations it appeared only about half as often (sixty-nine out of one hundred and thirty-seven times) in the catches of the tow-net. *C. franciscorum* was the only decapod found in Suisun Bay, as well as Napa Creek, and probably, therefore, can endure water of a lower salinity than any other species listed in connection with the survey.

Cancer magister, in spite of the fact that it is adapted primarily for living on sandy bottoms, was found well distributed throughout the region covered by the survey though not so abundantly as either of the preceding species. Within the bay it was actually taken more often on more or less muddy bottoms, but with very few exceptions

all the specimens were very much undersized. Together with *Crago nigricauda* and *C. franciscorum* this species is one of the only three that were taken at more than three stations in the upper bay, and together with these two and *Hemigrapsus oregonensis* is one of the only four taken at any of the upper bay stations lying north of Pinole Point.

In general *salinity* seems to be the controlling factor in the separation of the strictly outside species from those found in or "in and out" of the bay, and *character of bottom* that in the distribution of species within the bay. Though so important geographically, the effect of *temperature* on the local distribution of species is not at all evident. *Depth,* likewise, apparently exerts little or no influence on the distribution of the survey species: certain species were taken only beyond the 30 fathom line and others only in the course of shore collecting, but the relation of the former to the salinity outside, and the latter to their substratum is too intimate to permit any other explanation. That only four decapods are known to occur in the upper bay north of Pinole Point is probably due to the low salinity there obtaining, for although the annual range of temperature in this division is considerable it is almost equally great in the more populous but much more saline lower bay.

V. POSTSCRIPT

It is of more than passing interest to be able to notice, and compare here, the rather close correspondence between the conclusions set forth immediately above regarding the local distribution of the decapods of the Survey, and those independently arrived at by Packard (1918*a*, 1918*b*) as a result of his studies of the "Molluscan Fauna from San Francisco Bay," and published after the present paper had gone to press, viz:

"The character of the bottom appears to have the greatest significance in determining the local distribution of the mollusca" (1918*b*, p. 245). "Depth has little significance in determining the distribution of local forms ... the significance of the temperature factor is obscure" (1918*a*, p. 331). "The salinity factor is considered to be the major one in accounting for the meagerness of the fauna of the upper in contrast to that of the other divisions of the bay" (1918*b*, p. 245).

Recently in *The factors controlling the distribution of the Polynoidae of the Pacific coast of North America,* Miss Essenberg (1918) has adduced what appears to be further evidence in favor of Point Conception as a faunal barrier, marking a dividing line between a north temperate zone (extending north to Cape Flattery) and a north subtropical zone (extending south to Cape San Lucas).

But if we treat the species listed by Miss Essenberg in the same manner that the California decapods were dealt with under their *Geographical Distribution* above (pp. 281 to 286), we find of the twenty-eight species of littoral record (from 100 fathoms or less) from off California, that seven (25%), so far as known at present, are restricted to the region north of Point Conception, and nine (32%) to the region south of it, while twelve (43%) range both north and south.

Of these twenty-eight polynoids of littoral record, the bathymetric range of twelve (43%) reaches beyond the 100-fathom line. It does not, therefore, seem unreasonable to expect that with more intensive collecting and dredging a considerable number of species at present only found south, will be found north of Point Conception as well, and vice versa, especially in view of Miss Essenberg's warning that, "the distribution of some of the species is as yet inadequately known" (1918, p. 175).

VI. LITERATURE CITED

Agassiz, Alexander.

1892. General sketch of the expedition of the "Albatross," from February to May, 1891. Bull. Mus. Comp. Zool., 23, 1–89, pls. i–xxii.

Alcock, A.

1901*a*. A descriptive catalogue of the Indian deep-sea Crustacea Decapoda, Macrura and Anomala in the Indian Museum. Calcutta Indian Museum, 1–286, pls. 1–3.

1901*b*. Dromides. Catalogue Indian Decapod Crustacea. Calcutta Indian Museum, 1, fasc. 1, 1–80, pls. A, i–vii.

1905. Pagurides. *Ibid.*, 2, fasc. 1, xi + 197, pls. 1–16.

1906. The Prawns of the Peneus group. *Ibid.*, 3, fasc. 1, 1–55, pls. 1–9.

Allen, B. M.

1916. Notes on the spiny lobster (*Panulirus interruptus*) of the California coast. Univ. Calif. Publ. Zool., 16, 139–152, text figs. 1, 2.

Baker, C. F.

1912. Notes on the Crustacea of Laguna Beach. 1st Ann. Rep. Laguna Mar. Lab., 100–117, figs. 53–64.

Balss, H.

1913. Ostasiatische Decapoden. I, Die Galatheiden und Paguriden; Beiträge zur Naturgeschichte Ostasiens, hrsg. v. F. Doflein. Abh. d. math.-phys. Klasse d. k. bayer. Akad. Wiss., Munich. II, Suppl. Bd. 9, 1–85, pls. 1–2, text figs. 1–56.

1914. Ostasiatische Decapoden. II, Die Natantia und Reptantia. *Ibid.*, Suppl. Bd. 10, 1–101, pl. 1, text figs. 1–50.

Bartholomew, J. G., Clark, W. E., and Grimshaw, P. H.

1911. Atlas of zoögeography, *in* Bartholomew's physical atlas, 5, 1–67, pl. 36.

Bartsch, Paul.

1912. A zoögeographic study based on the pyramidellid mollusks of the west coast of America. Proc. U. S. Nat. Mus., 42, 297–349, pl. 40.

Bate, C. S.

1888. Report of the Crustacea Macrura, *in* "Challenger" Rept., Zool., 24, pp. xc + 942, pls. 1–150, text figs. 1–76.

Bauer, G.

1896. Grundzüge der marinen Tiergeographie; review of Ortmann's paper of that title, Science, n.s., 3, 359–367.

Benedict, J. E.

1901. The anomuran collections made by the Fish Hawk Expedition to Porto Rico. Bull. U. S. Fish Comm., 1900, 2, 129–148, pls. 3–6, 3 text figs.

1902. Description of a new genus and forty-six new species of crustaceans of the family Galatheidae with a list of the known marine species. Proc. U. S. Nat. Mus., 26, 243–334, text figs. 1–47.

1903. Revision of the Crustacea of the genus *Lepidopa*. *Ibid.*, pp. 889–895, text figs. 1–8.

1904. A new genus and two new species of crustaceans of the family Albuneidae from the Pacific Ocean, with remarks on the probable use of the antennulae in *Albunea* and *Lepidopa*. *Ibid.*, 27, 621–625, text figs. 1–5.

Blegvad, H.

1915. Food and conditions of nourishment among the communities of invertebrate animals found on or in the sea bottom in Danish waters. Rep. Danish Biol. Sta., 1914, **22**, 43–78, 4 text figs.

Borradaile, L. A.

1898. A revision of the Pontoniidae. Ann. Mag. Nat. Hist., (7), **2**, 376–391.

1903. On the classification of the Thalassinidea. *Ibid.*, **12**, 534–551.

1907. On the classification of the decapod crustaceans. *Ibid.*, **19**, 457–486.

1917*a*. On the structure and function of the mouth parts of the palaemonid prawns. Proc. Zool. Soc. London, pp. 37–71, text figs. 1–51.

1917*b*. On the Pontoniinae. Trans. Linn. Soc. London (Zool.), (2), **17**, 323–396, pls. 52–59.

Bouvier, E. L.

1895*a*. Sur une collection de Crustacés décapodes recueillis en Basse-Californie par M. Diguet. Bull. Mus. d'Hist. Nat., Paris, **1**, 6–9.

1895*b*. Recherches sur les affinité des Lithodes and des Lomis avec les Pagurides. Ann. sci. nat., Zool. (7), **18**, 157–213, pls. 11–13.

1896*a*. Sur la classification des Lithodines et sur leur distribution dans les oceans. *Ibid.*, (8), **1**, 1–46.

1896*b*. Les Pagurinés des mers d'Europe (Crustacés). Tableaux dichotomiques des genres et des espèces. La Feuille des Jeunes Naturalistes, (3), **26**, 125–128.

1898. Sur quelques Crustacés anomoures et brachyures recueillis par M. Diguet en Basse-Californie. Bull. Mus. d'hist. nat., Paris, **4**, 371–384.

Brandt, J. T.

1850. Vorlaüfige Bemerkungen über eine neue aus zwei noch unbeschriebenen Gattungen und Arten gebildete Unterabtheilung (Hapalogastrica) der Tribus Lithodina, begleitet von einer Charakteristik der eben genannten Tribus der Anomuren. Bull. phys.-math. Acad. St. Petersb., **8**, 266–269.

Brooks, W. K.

1882. Handbook of invertebrate zoology. (Boston, Cassino), pp. 1–392, text figs. 1–202.

Calman, W. T.

1906. Notes on some genera of the crustacean family Hippolytidae. Ann. Mag. Nat. Hist., (7), **17**, 29–34.

1909. Crustacea: Treatise on zoology; edited by Lankester. (London, Black), **7**, fasc. 3, pp. 1–346, text figs. 1–194.

1910. Crustacea, *in* Guide to the Crustacea, Arachnida, Onychophora and Myriopoda exhibited in the Department of Zoology, British Museum, pp. 11–76, figs. 1–51.

1911. The life of Crustacea. (London, Methuen), pp. 1–289, pls. 1–32, text figs. 1–85.

Clark, A. H.

1914. The circulation of the abyssal waters of the oceans, as indicated by the geographic and bathymetrical distribution of the recent Crinoids. Bull. Inst. Oceanog. Monaco, No. 285, pp. 1–27.

Coe, W. R.

1910*a*. Nemerteans of the Pacific coast of North America. I, The Nemerteans of the Expedition. Harriman Alaska Expedition, **11**, 1–110, pls. 1–13. (Originally published in Proc. Wash. Acad. Sci., **13**, 1–110, pls. 1–13, 1901.)

1910*b*. Nemerteans of the Pacific coast of North America. II, *ibid.*, pp. 111–202, pls. 14–22.

Collins, F. S.

1913. The marine Algae of Vancouver Island. Bull. Victoria Memorial Mus., **1**, 99–137.

Coutière, Henri.

1899. Les "Alphéidae," morphologie externe et interne, formes larvaires, bionomie, Ann. sci. nat., Zool., (8), **9**, pp. 1–559, text figs. 1–405, pls. 1–6.

1909. The American species of snapping shrimps of the genus *Synalpheus*. Proc. U. S. Nat. Mus., **36**, pp. 1–93, text figs. 1–54.

Dall, W. H.

1899. The mollusk fauna of the Pribilof Islands. Report of the fur seal investigations, 1896–1897, part 3, pp. 539–544, map.

1909. A collection of shells from Peru. Proc. U. S. Nat. Mus., **37**, 147–294, pl. 20–28.

1916. Checklist of the recent bivalve mollusks (Pelecypoda) of the northwest coast of America from the Polar Sea to San Diego, California. (Los Angeles, The Southwest Museum), pp. 1–44.

Dana, J. D.

1852–1853. Crustacea, parts 1, 2, *in* United States Exploring Expedition, **13**, **14**, pp. 1–1620; Folio atlas with 96 pls., 1855.

Doflein, F.

1899. Amerikanische Dekapoden der königlichen bayerischen Staatssammlungen. Sitzb. d. math.-phys. Classe d. k. bayer. Akad. d. Wiss., Munich, **29**, pp. 177–195.

1904. Brachyura. Wiss. Ergeb. "Valdivia" Exped., 1898–1899, **6**, part 3, Tiergeographischer Teil, pp. 267–276, text figs. 57–65.

Essenberg, Christine.

1918. The factors controlling the distribution of the Polynoidae of the Pacific coast of North America. Univ. Calif. Publ. Zool., **18**, 171–238, pls. 6–8, 2 figs. in text.

Faxon, Walter.

1895. The stalk-eyed Crustacea. Mem. Mus. Comp. Zool., **18**, 1–292, pls. 1–10.

Fisher, W. K.

1911. Asteroidea of the north Pacific and adjacent waters. Bull. U. S. Nat. Mus., **76**, 1–419, pls. 1–122.

Fraser, C. M.

1911. The Hydroids of the west coast of North America. Bull. Lab. Univ. Iowa, **6**, 1–91, pls. 1–8.

1913. Hydroids from Vancouver Island. Bull. Victoria Memorial Mus., **1**, 147–155, pls. 11–13.

1914. Some hydroids of the Vancouver Island region. Trans. Royal Soc. Canada, (3), **8**, 99–216, pls. 1–36.

Gerstaecker, A., and Ortmann, A. E.
1901. Malacostraca, *in* Bronn's Klassen u. Ordnungen d. Thierreich, **5**, pp. viii + 1319, pls. 1–128.

Gill, Theodore.
1885. The principles of zoögeography. Proc. Biol. Soc. Washington, **2**, 1–39.
1896. Principles of marine zoögeography. Science, n.s., **3**, 514–516.

Harrington, N. R., and Griffin, B. B.
1896–1897. Notes on the distribution, habits and habitat of some Puget Sound invertebrates. Trans. New York Acad. Sci., **16**, 152–165.

Henderson, J. R.
1888. Report on the Anomura, *in* "Challenger" Rep., Zool., **27**, 1–221, pls. 1–21.

Hilton, W. A.
1916. Crustacea from Laguna Beach. Jour. Ent. and Zool., Pomona College, California, **8**, 65–73, figs. 1–19.
1918. A list of some additional shrimp-like Crustacea [and hermit crabs] from Laguna Beach. *Ibid.*, **10**, 54.

Hofsten, Nils von.
1916. Die Decapoden Crustaceen des Eisfjords. Zool. Ergebnisse schwedischen Exped. Spitzbergen, 1908. Kongl. Svenska Vetenskaps Akad. Handlg., **54**, 1–108, 10 text figs., pls. 1 and 2.

Holmes, S. J.
1900. Synopsis of the California stalk-eyed Crustacea. Occas. Papers Calif. Acad. Sci., **7**, 1–262, pls. 1–4. (Contains complete bibliography to date.)
1904. On some new or imperfectly known species of West American Crustacea. Proc. Calif. Acad. Sci., (3), **3**, 307–330, pls. 35–37.

Ihle, J. E. W.
1912. Ueber einige neue, von der Siboga-expedition gesammelte Homolidae. Helder Tijdschr. Ned. dierk. Ver., (2), **12**, 206–214.
1913. Dromiacea *in* Die Decapoden Brachyura der Siboga-Expedition, Monograph XXXIX*b*, pp. 1–96, text figs. 1–38, pls. 1–4.

Jackson, H. G.
1913. Memoir on *Eupagurus*. Proc. and Trans. Liverpool Biol. Soc., **27**, 495–573, pls. 1–6, text figs. 1 and 2.

Kemp, Stanley.
1910. The Decapoda Natantia of the coast of Ireland. Sci. Invest. Fisheries Ireland, **1**, 1–190, pls. 1–23.

King, L. A. L., and Russel, E. S.
1909. A method for the study of the animal ecology of the shore. Proc. Royal Phys. Soc., Edinburgh, **17**, 225–253.

Kingsley, J. S.
1899*a*. The Caridea of North America. Amer. Nat., **33**, 709–720, text figs. 1–57.
1899*b*. Astacoid and Thalassinoid Crustacea. *Ibid.*, **33**, 819–824, text figs. 1–8.

Kofoid, C. A.
1915. Marine Biology on the Pacific Coast *in* Nature and science on the Pacific coast, pp. 124–132, text figs. 12 and 13, pls. xvi and xvii. (San Francisco, Paul Elder.)

Kükenthal, W.

1913. Ueber die Alcyonarienfauna Californiens und ihre tiergeographischen Beziehungen. Zool Jahrb., Abt. f. Syst. geog. u. biol. d. Tiere, Jena, 35, 219–269, pls. 7, 8, text figs. A–Z, A′–K′.

Lichti, P. A.

1914. Notes on the eggs of some Laguna Beach invertebrates. Jour. Ent. and Zool., Pomona College, 6, 215, 216.

Maas, Otto.

1893. On some problems of the distribution of marine animals. Nat. Sci., 2, 92–99.

1894. The effect of temperature on the distribution of marine animals. *Ibid.*, 5, 276–283.

McEwen, G. F.

1910. Preliminary report on the hydrographic work carried on by the Marine Biological Station of San Diego. Univ. Calif. Publ. Zool., 6, 189–204, text fig., map.

1912. The distribution of ocean temperature along the west coast of North America deduced from Ekman's theory of the upwelling of the cold water from the adjacent ocean depths. Intern. Rev. Hydrobiol. Hydrog., 5, 243–286, text figs. 1–21.

1915. Oceanic circulation and temperature off the Pacific coast, *in* Nature and science on the Pacific coast, pp. 130–140, text figs. 14–17. (San Francisco, Paul Elder.)

1916. Summary and interpretation of the hydrographic observations made by the Scripps Institution for Biological Research of the University of California, 1908–1915. Univ. Calif. Publ. Zool., 15, 255–356, pls. 1–38.

M'Intosh, W. C.

1904. On the distribution of marine animals. Ann. Mag. Nat. Hist., (7), 13, 117–130.

Mayer, A. G.

1914. The effects of temperature upon tropical marine animals. Papers, Tortugas Lab. Carnegie Inst., 6, 1–24 (Publ. 183).

Mead, H. T.

1917. Notes on the natural history and behavior of *Emerita analoga* (Stimpson). Univ. Calif. Publ. Zool., 16, 431–448, text fig. 1.

Murray, John, and Hjort, Johan.

1912. The depths of the ocean. (London, Macmillan), pp. xx + 821, text figs. 1–575, maps 1–4, pls. 1–9.

Nininger, H. H.

1918. Crabs taken at Laguna Beach in the summer of 1916. Jour. Ent. Zool., Pomona College, 10, 36–42, figs. 1–33.

Nobili, G.

1907. Nuove osservazioni sulla identita di *Brachycarpus neapolitanus* Cano e *Palaemon biunguiculatus* Lucas. (Includes a note suggesting the name *Periclimenes holmesi* for *Periclimenes tenuipes* (Holmes), preoccupied by *Periclimenes tenuipes* (Leach). Annuario Mus. Zool. Univ. Napoli (n.s.), 2, no. 21, pp. 1–5.

Ortmann, A. E.

1895*a*. A study of the systematic and geographic distribution of the decapod family Crangonidae Bate. Proc. Acad. Nat. Sci. Phila., 47, 173–197.

1895*b*. Grundzüge der marinen Thiergeographie. (Jena, Fischer), iv + 96 pp. It has not been possible to consult this paper directly. An excellent review is given in Science, see Bauer (1896) and Gill (1896) above. A map based on the original has been reproduced in Bartholomew's Atlas of zoögeography (1911, pl. 2).

1896. Principles of marine zoögeography. Science, n.s., **3**, 739–741.

PACKARD, E. L.

1918*a*. A quantitative analysis of the Molluscan fauna of San Francisco Bay. Univ. Calif. Pub. Zool., **18**, 299–336, pls. 12–13, 6 figs. in text.

1918*b*. Molluscan fauna from San Francisco Bay. Univ. Calif. Pub. Zool., **14**, 199–452, pls. 14–60.

PEARSE, A. S.

1913–1914. Observations on the fauna of the rock beaches at Nahant, Massachusetts. Bull. Wis. Nat. Hist. Soc., **11**, 8–34, figs. 1–30; **12**, 72–80.

PEARSON, JOSEPH.

1908. Memoir on *Cancer:* the edible crab. Proc. and Trans. Liverpool Biol. Soc., **22**, 291–499, pls. 1–13, text figs. 1–13.

PETERSEN, C. G. J., and JENSEN, P. B.

1914–1915. Valuation of the sea. II, The animal communities of the sea-bottom and their importance in marine zoögeography. Rep. Danish Biol. Sta., **21**, 1–44, app. 1–68, 1913; pls. 1–6, charts 1–3; **22**, app. 1–7, charts 1, 2, 1914.

RATHBUN, MARY J.

1893. Descriptions of new genera and species of crabs from the west coast of North America and the Sandwich Islands. Proc. U. S. Nat. Mus., **16**, 223–260.

1897. A revision of the nomenclature of the Brachyura. Proc. Biol. Soc. Washington, **11**, 153–167.

1898. The Brachyura collected by the U. S. Fish Commission Steamer "Albatross" on the voyage from Norfolk, Virginia, to San Francisco, California, 1887–1888. Proc. U. S. Nat. Mus., **21**, 567–616, pls. 41–44.

1900*a*. The cyclometopous or cancroid crabs of North America. Syn. N. A. Invert., Am. Nat. **34**, 131–143, text figs. 1–5.

1900*b*. The oxyrhynchous and oxystomatous crabs of North America. *Ibid.*, pp. 503–520, text figs. 1–15.

1900*c*. The catometopous or grapsoid crabs of North America. *Ibid.*, pp. 583–592, text figs. 1–15.

1901. The Brachyura and Macrura of Porto Rico. Bull. U. S. Fish Com., (1900), **20**, pt. 2, pp. 1–127, pls. 1–2, text figs. 1–24.

1902. Descriptions of new decapod crustaceans from the west coast of North America. Proc. U. S. Nat. Mus., **24**, 885–905.

1904*a*. Decapod crustaceans of the northwest coast of North America. Harriman Alaska Expedition, **10**, 1–210, pls. 1–9, text figs. 1–95.

1904*b*. Some changes in Crustacean nomenclature. Proc. Biol. Soc. Washington, **17**, 169–172.

1907. The Brachyura. Mem. Mus. Comp. Zool. Harvard College, **35**, 21–74, pls. 1–9.

1910. The stalk-eyed Crustacea of Peru and the adjacent coast. Proc. U. S. Nat. Mus., **38**, 531–620, pls. 36–56.

1918. The grapsoid crabs of North America. Bull. U. S. Nat. Mus., **97**, 1–444, pls. 1–159, figs. 1–172.

Rathbun, Richard.

1884. Crustaceans, *in* Fisheries and Fishery Industries of the United States, 47 Cong. 1 sess., Senate misc. doc. 124, sec. 1, part 5, Y, pp. 763–830, pls. 260–275, 1885. (Reprinted without change of page in 1893 *as* Natural History of Economic Crustaceans of the United States, with pl. 121 of the U. S. F. C. Bull. for 1889 added.)

Saunders, De Alton.

1910. The Algae of the Expedition. Harriman Alaska Expedition, **5**, 153–250, pls. 10–29. (Originally published in Proc. Wash. Acad. Sci., **3**, 391–486, pls. 10–29, 1901.)

Say, Thomas.

1818. An account of the Crustacea of the United States. Proc. Acad. Nat. Sci. Phila., 1, 235–253.

Schott, G., and Schu, F.

1910. Die Warmeverteilung in der Tiefen des stillen Ozeans. Ann. d. Hydrogr. marit. Meteorol., **38**, 2–25, 18 maps, pls. 1–15.

Selbie, C. M.

1914. The Decapoda Reptantia of the coast of Ireland. Pt. 1, Palinura, Astacura and Anomura (except Paguridea). Sci. Invest. Fisheries, Ireland, **1**, 1–116, pls. i–xv.

Setchell, W. A.

1893. On the classification and geographical distribution of the Laminariaceae. Trans. Connecticut Acad. Arts and Sci., **9**, 333–375.

Setchell, W. A., and Gardner, N. L.

1903. Algae of northwestern America. Univ. Calif. Publ. Bot., **1**, 165–418, pls. 17–27.

Shelford, V. E.

1911. Physiological animal geography. Journ. Morphology, **22**, 551–618, figs. 1–19.

1916. Physiological differences between marine animals from different depths. Puget Sd. Mar. Sta. Pub., **1**, 157–174, 1917.

Smith, G., and Welden, W. F. R.

1909. Crustacea. Cambridge Nat. Hist., **4**, 1–217, text figs. 1–135.

Smithsonian Institution.

1910. Opinions rendered by the International Commission on Zoological Nomenclature. Opinions 1 to 25. Smithson. Inst. Publ., **1938**, pp. 1–61.

Southern, R.

1915. Marine ecology. Proc. Royal Irish Acad., **31**, 1–110, pls. 1–3.

Steuer, Adolf.

1910. Planktonkunde. (Leipzig, Teubner), pp. 1–723, figs. 1–365.

Stimpson, W.

1860. Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit W. Stimpson. Pars VIII. Crustacea Macrura. Proc. Acad. Nat. Sci. Phila., **12**, 22–47, 1 text figure.

1907. Report on the Crustacea (Brachyura and Anomura) collected by the North Pacific Exploring Expedition, 1853–1856. Smithson. Misc. Coll., **49**, 1–240, pls. 1–26. Edited and annotated by Miss Mary J. Rathbun.

SUMNER, F. B., LOUDERBACK, G. D., SCHMITT, W. L., and JOHNSON, E. C.
1914. A report upon the physical conditions in San Francisco Bay based upon the operations of the U. S. Fisheries Steamer "Albatross" during the years 1912 and 1913. Univ. Calif. Publ. Zool., **14**, 1–198, pls. 1–13, text figs. 1–20.

SUMNER, F. B., OSBURN, R. C., COLE, L. J., and DAVIS, B. M.
1913. A biological survey of the waters of Woods Hole and vicinity. Bull. U. S. Bur. Fish., **31**, 1–860, charts 1–274.

TAYLOR, GEORGE.
1912. Preliminary list of one hundred and twenty-nine species of British Columbia decapod crustaceans. Contrib. Canad. Biol., **11**, 187–214.

THORADE, H.
1909. Uber die kalifornische Meeresströmungen, Oberflächen temperaturen und Strömungen an der Westküste Nordamerikas. Ann. Hydr. u. marit. Meteor., **37**, 17–34, 63–77, pls. 5, 10 and 11, 5 text figs.

TORREY, H. B.
1902. The Hydroida of the Pacific coast of North America. Univ. Calif. Publ. Zool., **1**, 1–104, pls. 1–11.

TOWNSEND, C. H.
1893. Report of observations respecting the oyster resources and oyster fishery of the Pacific coast of the United States. Rep. U. S. Fish Comm., 1889–1891, pp. 343–372, pls. 2–11.

VERRILL, A. E.
1914. Monograph of shallow-water starfishes of the north Pacific coast from the Arctic Ocean to California. Harriman Alaska Expedition, **14**, 1–388, pls. 1–110.

VERRILL, A. E., and SMITH, S. I.
1873. Report upon the invertebrate animals of Vineyard Sound and adjacent waters, with an account of the physical characters of the region. Rep. U. S. Fish Comm., 1871–1872, pp. 295–778, pls. 1–38.

WAY, EVELYN.
1917. Brachyura and Crab-like Anomura of Friday Harbor, Washington. Puget Sd. Mar. Sta. Pub., **1**, 349–382, pls. 78–82.

WEBER, FRIDERICUS.
1795. Nomenclator entomologicus secundum Entomologiam systematicam ill. Fabricii adjectis speciebus recens detectis et varietatibus. (Chilonii [Kiel] et Hamburgi, Bohn), viii + 171 pp.

WEYMOUTH, F. W.
1910. Synopsis of the true crabs (Brachyura) of Monterey Bay, California. Leland Stanford Jr. Univ. Publ., Univ. Ser., no. 4, pp. 1–64, pls. 1–14, text figs. 1–9.
1914. Contributions to the life-history of the Pacific coast edible crab (*Cancer magister*). Rept. Brit. Columbia Comm. Fish., pp. 123–129, figs. 1–8.

WEYMOUTH, F. W., and RICHARDSON, C. H., Jr.
1912. Observations on the habits of the crustacean *Emerita analoga*. Smithson. Misc. Coll., **59**, 1–13, pl. 1.

WOODWARD, S. P.
1854–1856. Manual of the Mollusca. (London, Weale), pp. 373–486, pls. 1–24, text figs. 1–272, 1 map.

VII. APPENDIX I

Distributional List of the Marine Decapod Crustacea of California

This list is almost wholly based on the one given by Miss Rathbun in her *Harriman Alaska Expedition Report* (1904*a*, pp. 8–17), with some additions from the U. S. National Museum collections, and several of the more recent authors. The species are in systematic order in the first column of the table. All of those dealt with in the section on "Distribution" (p. 281) are in roman type. Those taken in connection with the biological survey of San Francisco Bay are printed in **bold face** type, while species from depths exceeding 100 fathoms are *italicized.*

Since drawing up this table it has been found desirable to distinguish between the species whose bathymetric range is not known to exceed 30 fathoms and those which, though found within the 100-fathom line have not been taken, at least off the California coast, in 30 fathoms or less. The names of the former are followed by a black spot ●, the latter by a ◐.

In the second column the northern limits of the ranges of the various species are given. In the case of Alaskan forms these as a matter of convenience, have been reduced to one of several generalized limits, i.e., Sitka, for all species whose range terminated there or between that point and the northern boundary of British Columbia; Kadiak, for the Sitka to Kadiak species; and the Aleutian Islands, for those reaching, but not running into the Bering Sea. As a matter of interest the northern limits of all species reported from the Straits of Fuca or Puget Sound have been marked with an asterisk.*

The southern limits given in the next to the last column have been similarly grouped in the case of Lower Californian species under Todos Santos Bay, San Geronimo Island, Point San Eugenio (Cerros Island), Magdalena Bay, and the Gulf of California, respectively.

The last column gives records of exceptional occurrence and of world distribution.

The remaining nine columns cover the distribution along the coast of California. Records of species from 100 fathoms or less are indicated by circular black spots, ●; those between 100 and 500 fathoms by a circle with a dot at the center, ⊙; and over 500 fathoms by a ○.

In a number of instances these symbols are accompanied by one or more index figures. When standing alone, an index figure signifies that the species in question has been found only at the locality referred to within the region delimited by the heading of the column in which it occurs; a plus sign (+) preceding the figure indicates that the species has also been found at the locality for which the index figure stands. Obviously where the stated northern and southern limit of a species restricts it to a particular locality the use of an index figure is unnecessary, yet they have been employed in all cases where one has been available.

The index figures and the localities for which they stand are:

1. Pigeon Point
2. Point Conception
3. Santa Barbara Channel
4. Laguna Beach
5. San Francisco Bay
6. Santa Barbara
7. San Clemente Island
8. San Nicolas Island
9. Santa Barbara Island
10. Half Moon Bay
11. Humboldt Bay
12. Farallon Islands

The heading Santa Barbara Islands includes only San Miguel, Santa Rosa, Santa Cruz, and Anacapa. San Nicolas and Santa Barbara Island are separately indicated in the same column (index numbers 8 and 9), while San Clemente (index number 7) is included in the third column following, headed Santa Catalina Island.

Species	Northern limit	California Boundary–Cape Mendocino	Cape Mendocino–Point Reyes	Point Reyes–Monterey Bay	Monterey Bay–Point Conception	Santa Barbara Islands (Pt. Conception–Pt. Dume)	Santa Monica Bay (Pt. Dume–Pt. Vincente)	San Pedro Bay (Pt. Vincente–La Jolla)	Santa Catalina Island	San Diego (La Jolla–Mexican Boundary)	Southern limit	Addenda
Sergestes similis	Washington		⊙	○	⊙	⊙ ○ [2+3+8]	. .	⊙	⊙ ○ [+7]	⊙ ○	Gulf of California	Japan
Peneus brevirostris ●	San Francisco			● [5]	. .	. .	●	●	.....	●	Peru	Galapagos Isls.
Benthesicymus altus	San Clemente Isl.		. .	. . .	. . .	..	.....	. . .	○ [7]	.. . ..	South Pacific	Philippines; Japan; South Atlantic, off Tristan da Cunha; Gulf of Panama; Galapagos Isls.
Benthesicymus tanneri	San Diego		.	.	.	.	.	.	.. .	○	Gulf of California	Ecuador; Galapagos Isls.
Gennadas borealis	Aleutian Isls.			.		○ [8]			⊙	.	Todos Santos Bay	
Gennadas pectinatus	Santa Catalina Isl		.	..				○	.....	.....	Santa Catalina Isl.	
Pasiphaea magna	Point Arena		⊙	⊙ ○	○	.		○	○ [7]	⊙ ○	Panama	
Pasiphaea pacifica ◐	Aleutian Isls.*	....		⊙ [1]	● ⊙ ○	⊙ ○ [+2+8]	.	⊙	.....	⊙	Gulf of California	
Pasiphaea emarginata	Santa Barbara Chan.		.			⊙ [3]		.		. .	Gulf of California	
Pasiphaea corteziana	Cortez Bank			....						○	Cortez Bank	
Pasiphaea affinis	Cortez Bank	.		...					. .	○	Cortez Bank	
Parapasiphae serrata	Cortez Bank			. .		.		.	..	○	Cortez Bank	
Acanthephyra curtirostris	San Clemente Isl.			.			.....	.....	○ [7]	○	Panama	Arabian Sea; Bay of Bengal; Andaman Sea
Hymenodora frontalis	Bering Sea				⊙	○			○ [+7]	....	San Clemente Isl.	Kamchatka
Palaemon ritteri ●	San Diego		.			.			..	●	Gulf of California	Ecuador
Palaemonetes hiltoni ●	San Pedro	...				.		●	.....	.....	San Pedro	
Urocaris infraspinis ●	San Diego	.. ...	... .	... .	.... .	. . ..	. . .	.. ...	.... ..	●	Gulf of California	
Pontonia californiensis ●	Santa Cruz Isl.	. ...	...	...	. ....	●	.	. . .	...	..	Santa Cruz Isl.	

Periclimenes tenuipes ●	Santa Catalina Isl.								●		Gulf of California	
Pandalus jordani	Aleutian Isls.*		●⊙	●	●⊙	⊙+8		⊙		⊙	San Diego	
Pandalus montaqui tridens	Bering Sea		⊙			○8					San Nicolas Isl.	
Pandalus platyceros	Aleutian Isls.*		⊙	⊙	●⊙	⊙+2+8		●	⊙	●⊙	San Diego	Japan
Pandalus danae	Sitka, Alaska*			●+5							San Francisco	
Pandalus gurneyi	Monterey Bay				●	●+6		●	●		Santa Catalina Isl.	
Pandalopsis ampla	Washington					⊙○+8			○7	⊙○	Tres Marias Isls., Mexico	
Hippolyte californiensis ●	Sitka, Alaska*		●					●+4		●	San Diego	
Hippolysmata californica ●	Santa Barbara					●6	●	●+4	●	●	San Diego	
Spirontocaris prionota	Bering Sea*				●						Monterey Bay	Japan
Spirontocaris lamellicornis	Aleutian Isls.*		●								Point Arena	
Spirontocaris bispinosa	Sitka, Alaska*		●⊙	⊙	●⊙	⊙8		⊙	⊙	⊙	San Diego	
Spirontocaris snyderi ◐	Puget Sound*				●	●		●	●		Pt. San Eugenio, Lower Cal.	
Spirontocaris sica	Point Arena		⊙	⊙	⊙⊙	⊙○+2+3+8		⊙	⊙○+7	⊙○	San Diego	
Spirontocaris washingtoniana	Washington					○8			⊙7		San Clemente Isl.	
Spirontocaris affinis ●	Monterey Bay				●						Monterey Bay	
Spirontocaris lagunae	Laguna Beach							●4			Laguna Beach	
Spirontocaris flexa	Bering Sea			●							Drakes Bay	
Spirontocaris gracilis	Aleutian Isls.*			●	●		●		●		Santa Catalina Isl.	
Spirontocaris franciscana ●	San Francisco			●5				●4			Laguna Beach	
Spirontocaris decora ◐	Straits of Fuca*				●	●⊙+2		●?		●⊙	San Diego	
Spirontocaris carinata	Monterey Bay				●			●4		●	San Diego	
Spirontocaris kincaidi	Puget Sound*				●			●			San Pedro	
Spirontocaris layi ●	British Columbia				●						Monterey Bay	
Spirontocaris paludicola ●	British Columbia	●11	●	●5+10	●?				●?	●	San Diego	
Spirontocaris palpator ●	San Francisco			●5	●			●+4	●	●	Magdalena Bay, Lower Cal.	
Spirontocaris brevirostris ●	Aleutian Isls.*	●		●5							San Francisco	
Spirontocaris taylori ●	San Francisco			●+5	●		●	●+4		●	Magdalena Bay, Lower Cal.	
Spirontocaris picta ●	Monterey Bay				●			●+4	●	●	San Diego	

DISTRIBUTIONAL LIST OF THE MARINE DECAPOD CRUSTACEA OF CALIFORNIA—(*Continued*)

Species	Northern limit	California Boundary—Cape Mendocino	Cape Mendocino—Point Reyes	Point Reyes—Monterey Bay	Monterey Bay—Point Conception	Santa Barbara Islands (Pt. Conception—Pt. Dume)	Santa Monica Bay (Pt. Dume—Pt. Vincente)	San Pedro Bay (Pt. Vincente—La Jolla)	Santa Catalina Islands	San Diego (La Jolla—Mexican Boundary)	Southern limit	Addenda
Spirontocaris cristata	Sitka, Alaska*			●[5]	●		●	●	●	●	San Diego	
Spirontocaris brachydactyla	Santa Cruz Isl.					⊙				⊙	San Diego	
Spirontocaris macrophthalma	Aleutian Isls.		⊙	⊙	⊙⊙						Point Sur	
Crangon dentipes●	Farallon Isls.			●[12]	●	●[6]	●	●[14]	●	●	Magdalena Bay, Lower Cal.	Mediterranean; Cape Verde Isls.; Bermudas; West Indies; Key West
Crangon bellimanus●	Monterey Bay				●	●[6]	●	●	●	●	Chile	
Crangon barbara●	Santa Barbara					●[6]					Santa Barbara	
Crangon californiensis●	San Pedro							●			Magdalena Bay, Lower Cal.	
Crangon equidactylus●	Monterey Bay				●	●[6]					Santa Barbara	
Synalpheus lockingtoni	San Nicolas Isl.					○[8]	●		●		Gulf of California	
Betaeus harfordi	Pt. Arena		●		●	●[6]	●	●[4]	●		Santa Catalina Isl.	
Betaeus longidactylus	San Pedro						●	●[14]	●	●	San Diego	
Processa canaliculata	San Diego									●	Panama	Europe; Madeira; Bermudas; North Carolina to Trinidad; Gulf of Mexico; West Indies; Japan; Amboina
Crago nigricauda	British Columbia*	●	●	●[15]	●			●[14]	●	●	San Geronimo Isl., Lower Cal.	Japan
Crago nigromaculata	Bodega Bay		●	●[15]	●		●	●[14]		●	Magdalena Bay, Lower Cal.	
Crago alaskensis elongata	British Columbia*		●	●	●	●[6]	●	●	●	●	U.S.—Mexican Boundary line	
Crago alba	British Columbia			●	●	●[8]	●	●[14]		●	San Diego	
Crago holmesi	San Pedro					●[8]		●[14]	●		Pt. San Eugenio, Lower Cal.	

Crago stylirostris ●	Aleutian Isls.*	●		●+5	●						Monterey Bay	
Crago franciscorum ●	Sitka, Alaska*		●	●+5	●					●	San Diego	
Crago communis	Bering Sea*		●⊙	●⊙	●⊙					⊙	San Diego	Kamchatka
Crago resima	San Francisco			●	●⊙	●⊙○+2	8+9			●⊙	●⊙	Magdalena Bay, Lower Cal.
Crago abyssorum	Bering Sea				○						○	Cortez Bank
Crago munita	Kadiak, Alaska*					●+2					San Miguel Isl.	
Crago acclivis ◐	Aleutian Isls.					⊙+8			●⊙		San Nicolas Isl.	
Crago variabilis	Bering Sea					○+8					San Nicolas Isl.	
Crago spinosissima	Oregon		●	●	●	●2		●		⊙	San Diego	
Crago lomae	San Diego									⊙⊙	San Diego	
Crago munitella	Puget Sound*			●5	●			●+4	●		Santa Catalina Isl.	
Nectocrangon californiensis ◐	Santa Cruz Isl.					⊙			●		Santa Catalina Isl.	
Paracrangon echinata ◐	Kadiak, Alaska*				●	●				⊙	La Jolla	Japan
Eryonicus agassizi	San Nicolas Isl.					○8					Panama	
Panulirus interruptus	Monterey Bay?				●?	●+6		●+4	●	●	Pt. San Eugenio, Lower Cal.	Mexico
Axiopsis spinulicauda ◐	Bodega Head		●								Bodega Head	
Calastacus investigatoris	Aleutian Isls.					○8				⊙	San Diego	Arabian Sea
Calastacus quinqueseriatus	Point Sur				⊙	⊙+2+3					Anacapa Isl.	
Upogebia pugettensis ●	Sitka, Alaska*		●	●5	●			●	●	●	San Geronimo Isl., Lower Cal.	
Callianassa californiensis ●	Sitka, Alaska*		●	●5		●6		●+4		●	Tia Juana River	
Callianassa longimana ●	British Columbia*			●5		●9		●+4	●	●	San Geronimo Isl., Lower Cal.	
Callianassa gigas ●	Puget Sound*			●							San Francisco	
Callianassa affinis ●	Santa Monica Bay						●	●	●+7	●	San Diego	
Callianassa goniophthalma	Sitka, Alaska					⊙○2					San Miguel Isl.	
Paguristes turgidus	British Columbia*		●	●	●⊙			●	●	●⊙	San Diego	
Paguristes parvus ●	San Pedro							●			San Pedro	
Paguristes bakeri	San Francisco			●		●8	●	●+4	●	●⊙	Gulf of California	
Paguristes ulreyi	Monterey Bay				●	●+8	●	●+4		●	San Geronimo Isl., Lower Cal.	
Dardanus jordani ●	San Francisco Bay			●5							San Francisco Bay	

DISTRIBUTIONAL LIST OF THE MARINE DECAPOD CRUSTACEA OF CALIFORNIA—(*Continued*)

Species	Northern limit	California Boundary—Cape Mendocino	Cape Mendocino—Point Reyes	Point Reyes—Monterey Bay	Monterey Bay—Point Conception	Santa Barbara Islands (Pt. Conception—Pt. Dume)	Santa Monica Bay (Pt. Dume—Pt. Vincente)	San Pedro Bay (Pt. Vincente—La Jolla)	Santa Catalina Island	San Diego (La Jolla—Mexican Boundary)	Southern limit	Addenda
Holopagurus pilosus ●	San Francisco			●				●+4		●	San Diego	
Pagurus ochotensis	Aleutian Isls.*			●	●		●	●		●	San Diego	Okhotsk Sea; Japan
Pagurus capillatus	Arctic Alaska*				⊙						Monterey Bay	Kamchatka
Pagurus tinneri	Aleutian Isls.		⊙	⊙	⊙						San Simeon Bay	
Pagurus beringanus ●	Bering Sea*				●						Monterey Bay	
Pagurus setosus	Sitka, Alaska*					⊙					Santa Cruz Isl.	
Pagurus hirsutiusculus ●	Bering Sea*	●11		●9+10	●			●+4		●	San Diego	Siberia; Kamchatka; Japan
Pagurus samuelis ●	Humboldt County	●	●	●5+10	●		●	●+4	●	●	San Diego	Japan
Pagurus granosimanus ●	Aleutian Isls.*	●		●10	●			●		●	Todos Santos Bay, Lower Cal.	
Pagurus hemphillii ●	British Columbia	●			●						Monterey Bay	
Pagurus californiensis	Monterey Bay?				●?				●		Gulf of California	
Pylopagurus minimus	British Columbia			●	●		●	●+4		●	San Diego	
Pylopagurus holmesi ●	San Pedro							●	●	●	San Diego	
Parapagurus pilosus ●	Kadiak, Alaska				●	●⊙+8					San Nicolas Isl.	Kamchatka
Hapalogaster cavicauda ●	Kadiak, Alaska				●	●8			●7		San Clemente Isl.	
Hapalogaster grebnitzkii ●	Bering Sea	●11									Humboldt Bay	
Oedignathus inermis ●	Aleutian Isls.*	●		●5	●						Monterey Bay	Japan
Acantholithodes hispidus	Aleutian Isls.			●	●						Monterey Bay	
Phyllolithodes papillosus	Aleutian Isls.*				●						Monterey Bay	

Cryptolithodes typicus ●	Aleutian Isls.*				●						Monterey Bay	
Cryptolithodes sitchensis ●	Sitka, Alaska*	●	●		●						Monterey Bay	
Lopholithodes mandtii	Sitka, Alaska			●	●						Monterey Bay	
Lopholithodes foraminatus	British Columbia*			●	●⊙	●⊙+8			⊙	⊙	San Diego	
Rhinolithodes wosnes-senskii ●	Kadiak, Alaska	●									Crescent City	
Paralomis multispina	Aleutian Isls.				○					○	San Diego	
Paralomis verrilli	Bering Sea				○					○	Cortez Bank	
Paralithodes rathbuni	San Simeon Bay				⊙					⊙	San Diego	
Paralithodes californiensis	Santa Cruz Isl.					⊙				⊙	San Diego	
Lithodes couesi	Bering Sea								○7	⊙○	San Diego	
Pleuroncodes planipes ●	90 miles S. W. San Francisco				●						150 miles S. W. Cape St. Lucas, Lower Cal.	
Galathea californiensis ◐	Monterey Bay				●⊙	⊙		●⊙	○	●⊙○	Pt. San Eugenio, Lower Cal.	
Munida quadrispina ◐	Sitka, Alaska*		⊙	⊙	●⊙	⊙○+3+8+9		⊙	⊙○+7	⊙○	Todos Santos Bay, Lower Cal.	
Munida hispida	Santa Catalina Isls.								⊙	⊙	Pt. San Eugenio, Lower Cal.	
Munidopsis hystrix	Anacapa Isl.					⊙○+9					Acapulco, Mexico	Clarion Isl.
Munidopsis verrilli	Monterey Bay				○	○8				○	Pt. San Eugenio, Lower Cal.	
Munidopsis quadrata ◐	Washington					⊙		●	⊙○+7	●⊙○	Tres Marias Isls., Mexico	
Munidopsis aspera ◐	San Clemente Isl.							●	⊙○+7	●⊙○	Straits of Magellan	Galapagos Isls.; Brazil
Blepharipoda occidentalis ●	San Francisco			●	●	●6	●	●+4		●	Pt. San Eugenio, Lower Cal.	
Lepidopa myops ●	San Pedro							●+4		●	Cape St. Lucas, Lower Cal.	
Emerita analoga ●	Oregon			●+5-10	●	●+6+8	●	●+4	●7	●	Magdalena Bay, Lower Cal.	Peru; Chile
Pachycheles rudis ●	Kadiak, Alaska*			●+10	●	●	●	●+4	●	●	Lower California	
Pachycheles holosericus ●	Santa Monica Bay						●	●+4		●	San Diego	
Pachycheles pubescens ●	Puget Sound*	●		●+5	●						Monterey Bay	Japan
Petrolisthes cinctipes ●	British Columbia*	●	●	●5-10	●	●	●	●+4	●		Gulf of California	
Petrolisthes eriomerus ●	British Columbia*			●+10	●		●	●	●	●	Magdalena Bay, Lower Cal.	
Petrolisthes gracilis ●	Monterey Bay				●				●?	●	Gulf of California	
Petrolisthes rathbunae ●	Monterey Bay				●	●	●	●4	●+7		San Clemente Isl.	

DISTRIBUTIONAL LIST OF THE MARINE DECAPOD CRUSTACEA OF CALIFORNIA—(*Continued*)

Species	Northern limit	California Boundary—Cape Mendocino	Cape Mendocino—Point Reyes	Point Reyes—Monterey Bay	Monterey Bay—Point Conception	Santa Barbara Islands (Pt. Conception—Pt. Dume)	Santa Monica Bay (Pt. Dume—Pt. Vincente)	San Pedro Bay (Pt. Vincente—La Jolla)	Santa Catalina Island	San Diego (La Jolla—Mexican Boundary)	Southern limit	Addenda
Dromidia larraburei ●	Monterey Bay				●			●			Peru	Galapagos Isls.
Homola faxoni ◐	San Diego									●⊙	San Diego	
Cyclodorippe plana ●	Monterey Bay ?				●?			●+4	●		Santa Catalina Isl.	
Randallia ornata	Mendocino County		●	●	●	●+6	●	●+4	●	●	Magdalena Bay, Lower Cal.	
Randallia bulligera ●	San Diego									●	Magdalena Bay, Lower Cal.	
Mursia gaudichaudii	Farallon Isls.			+10+12 ●	●⊙	●+6		●	●	●⊙	Chile	
Heterocrypta occidentalis	Gulf of the Farallones			●	●		●	●+4	●	●	Coronados Isls., Lower Cal.	
Podochela hemphillii	Monterey Bay				●		●	●4	●	●	Gulf of California	
Anasimus spinosus	Monterey Bay?				●?	●+8		●	●	●	Pt. San Eugenio, Lower Cal.	
Oregonia gracilis	Bering Sea*	●		●	●						Monterey Bay	Japan
Inachoides tuberculatus	Monterey Bay				●		●	●+4		●	Panama	
Epialtus productus ●	British Columbia*			●+5+10	●	●6	●	●+4	●+7	●	Pt. San Eugenio, Lower Cal.	
Epialtus nuttallii ●	Santa Barbara					●6	●	●+4	●	●	Magdalena Bay, Lower Cal.	
Epialtus bituberculatus ●	Monterey Bay?				●?			●4	●?		Chile	Indian River, Florida to Rio de Janeiro, Brazil, Bermudas.
Mimulus foliatus ●	Aleutian Isls.*				●						Mazatlan, Mexico	
Pugettia gracilis	Aleutian Isls.*	●		●12							South'n California?	
Pugettia richii ●	British Columbia*				●		●	●+4	●	●	San Diego	
Pugettia dalli ●	San Pedro					●	●	●+4	●+7	●	San Geronimo Isl., Lower Cal.	

Chorilia longipes	Kadiak, Alaska*		●	●	●⊙○	⊙○+8+9			⊙○+7	●⊙○	San Diego		
Chionoecetes tanneri	Bering Sea			●⊙	⊙○	⊙○+2+9			⊙○+7	⊙○	San Diego		
Pelia tumida ●	Santa Monica Bay						●	●+4	●	●	Magdalena Bay, Lower Cal.		
Pelia clausa ●	Santa Monica Bay						●	●+4	●+7	●	Gulf of California		
Loxorhynchus grandis	Point Reyes			●	●	●6		●	●	●	San Diego		
Loxorhynchus crispatus	Point Reyes			●+5	●	●+2+6+8	●	●	●	●	San Diego		
Scyra acutifrons	Kadiak, Alaska*			●	●	●	●	●+4	●	●	San Diego		
Herbstia parvifrons	Monterey Bay				●		●	●+4	●+7	●	Acapulco, Mexico		
Cancer productus ●	Kadiak, Alaska*		●	●+5+10	●			●4			Magdalena Bay, Lower Cal.		
Cancer amphioetus	San Diego									●	Gulf of California	Japan; Korea	
Cancer antennarius ●	British Columbia			●5	●	●6	●	●+4	●	●	Magdalena Bay, Lower Cal.		
Cancer gibbosulus	Kadiak, Alaska			●5	●			●+4	●		San Geronimo Isl., Lower Cal.	Japan	
Cancer anthonyi	San Pedro						●	●	●	●	Pt. San Eugenio, Lower Cal.		
Cancer jordani	Half Moon Bay			●10	●		●	●+4	●	●	San Geronimo Isl., Lower Cal.?		
Cancer magister	Aleutian Isls.*			●+5	●						Magdalena Bay, Lower Cal.		
Cancer gracilis	Sitka, Alaska*		●	●+5	●	●6	●	●+4		●	Pt. San Eugenio, Lower Cal.		
Cancer oregonensis	Aleutian Isls.*			●		●6					Lower California		
Telmessus cheiragonus ●	Bering Sea*	●									California (probably near northern state boundary).	Siberia; Kamchatka; Kurile Isls.	
Callinectes bellicosus ●	San Diego									●	Gulf of California		
Portunus xantusii ●	Puget Sound?						●	●+4	●	●	Chile		
Cycloxanthops novemdentatus ●	Monterey Bay				●		●	●+4	●+7	●	San Geronimo Isl., Lower Cal.	Guadalupe Isl.	
Cycloxanthops rugosus ●	San Diego									●	San Diego		
Lophopanopeus bellus ●	Kadiak, Alaska*				●?						Lower California?		
Lophopanopeus frontalis ●	Santa Monica Bay						●		●	●	San Diego		
Lophopanopeus heathii ●	Monterey Bay				●			●4	●		Santa Catalina Isl.		
Lophopanopeus leucomanus ●	Monterey Bay				●	●	●	●+4	●	●	San Diego		
Lophopanopeus lockingtoni ●	San Pedro							●		●	Gulf of California		
Lophopanopeus diegensis	Monterey Bay				●	●2	●	●	●	●	San Diego		

DISTRIBUTIONAL LIST OF THE MARINE DECAPOD CRUSTACEA OF CALIFORNIA—(*Concluded*)

Species	Northern limit	California Boundary—Cape Mendocino	Cape Mendocino—Point Reyes	Point Reyes—Monterey Bay	Monterey Bay—Point Conception	Santa Barbara Islands (Pt. Conception—Pt. Dume)	Santa Monica Bay (Pt. Dume—Pt. Vincente)	San Pedro Bay (Pt. Vincente—La Jolla)	Santa Catalina Island	San Diego (La Jolla—Mexican Boundary)	Southern limit	Addenda
Xanthias taylori	Monterey Bay				●	●[8]	●	●[+4]	●[+7]	●	Magdalena Bay, Lower Cal.	
Xanthias latimanus ●	San Diego									●	San Diego	
Pilumnus spinohirsutus ●	Santa Monica Bay						●		●	●	Gulf of California	Ecuador
Heteractaea lunata ●	San Diego									●	Chile	
Speocarcinus californiensis ●	San Pedro							●		●	San Diego	
Pinnotheres holmesi ●	Pacific Grove				●						Pacific Grove	
Pinnotheres nudus ●	Monterey Bay				●						Monterey Bay	
Pinnotheres concharum ●	British Columbia*		●		●	●		●		●	San Diego	
Fabia subquadrata	Aleutian Isls.*				●			●[4]			Laguna Beach	
Fabia lowei ●	Santa Monica Bay						●	●[4]	●[7]	●	San Diego	
Fabia canfieldi ●	Monterey Bay				●						Monterey Bay	
Parapinnixa affinis ●	San Pedro							●			San Pedro	
Pinnixa longipes ●	Tomales Bay		●					●[+4]			Laguna Beach	
Pinnixa tomentosa ●	San Clemente Isl.								●[7]		Gulf of California	
Pinnixa faba ●	Sitka, Alaska*	●[11]						●			San Pedro	
Pinnixa littoralis ●	Sitka, Alaska*	●[11]	●	●[5]				●[4]	●	●	San Diego	
Pinnixa barnharti ●	Santa Monica Bay						●	●		●	Ballenas Bay, Lower Cal.	
Pinnixa occidentalis	Aleutian Isls.*			●	●					●	Magdalena Bay, Lower Cal.	
Pinnixa franciscana ●	San Francisco			●[5]							San Francisco	

Pinnixa schmitti	Aleutian Isls.*	.....	●[5]	.....	.....	.....	.....	.....	San Francisco	
Pinnixa hiatus ◐	Santa Catalina Isl.	.....	.....	.....	.....	.....	.....	●	Santa Catalina Isl.	
Pinnixa tubicola	Puget Sound*	●	●	.....	●	●[2]	.....	●	.....	●	San Diego	
Pinnixa weymouthi ●	Monterey Bay	.....	.....	.....	●	.....	.....	.....	.....	.....	Monterey Bay	
Scleroplax granulata ●	Puget Sound*	.....	●	●[5]	.....	.....	.....	.....	.....	.....	Todos Santos Bay, Lower Cal.	
Oristhopus transversus	Monterey Bay	.....	.....	.....	●	.....	●	●[+4]	●	●	San Diego	
Pachygrapsus crassipes ●	Oregon	●	.....	●[5+10]	●	●[6]	●	●[+4]	●[+7]	●	Gulf of California	Galapagos Isls.; Chile; Japan; Korea
Pachygrapsus transversus ●	California (probably near southern boundary)	.....	.....	.....	.....	.....	.....	.....	.....	●	Peru	Galapagos Isls.; Oriental region; West Africa; Bermudas; Bahamas and Florida Keys to Rio de Janeiro, Brazil
Planes minutus ●	Humboldt Bay	●	.....	.....	.....	.....	.....	●	●	●	Temperate and tropical seas	
Hemigrapsus nudus ●	Sitka, Alaska*	.....	.....	●[5+10]	●	●[6]	.....	●	●	●	Gulf of California	
Hemigrapsus oregonensis ●	Kadiak, Alaska*	●	●	●[5]	●	●[6]	●	●[+4]	●	●	Gulf of California	
Grapsodius eximius ●	San Diego	.....	.....	.....	.....	.....	.....	.....	.....	●	San Diego	
Ocypode gaudichaudii ●	San Francisco?	.....	.....	●[5?]	.....	.....	.....	.....	.....	.....	Chile	Nicaragua; Galapagos Isls.; Honolulu
Uca crenulata ●	San Diego	.....	.....	.....	.....	.....	.....	.....	.....	●	Gulf of California	
Uca musica ●	British Columbia*	.....	.....	.....	.....	.....	.....	.....	.....	●	Gulf of California	

VIII. APPENDIX II A

List of Species Taken at "Albatross" Dredging Stations During the Years 1912 and 1913

Only such data are reproduced here as have been used in the discussion of the distribution of the species listed. All other dredging data are to be found in the *Report on the Physical Conditions in San Francisco Bay* (Sumner, 1914).

Unless obtained at more than three stations the species and number of specimens taken at the various stations are entered in the column of "Addenda." *Cancer antennarius* is the only exception to this rule.

Fifty or more specimens are represented by the letter "m" (many). The actual count of lesser numbers is given in full.

The positions of these stations are plotted on plates 2 and 3, and in order that they might be readily located they are referred to the "upper," "middle" or "lower" regions of the bay or to the region "outside."

The "upper" bay is taken as the section lying north of a line connecting Point San Pedro and Point San Pablo, including the region usually designated as San Pablo Bay. The "middle" bay extends from this line to one drawn from the San Francisco Ferry Building through the Goat Island Light, and separating it from the "lower" bay, the section below this latter line. The "middle" bay is separated from the region "outside" by a line passing from the Bonita Point Light through Mile Rock to the San Francisco shore.

As a rule hydrographic observations were not made in the course of dredging operations, and in order that such data obtained at the regular hydrographic stations might be used in connection with the dredging stations a table correlating the two has been drawn up as Appendix III (p. 354) of this report.

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Middle	1912	fms.									
D 5700	Jan. 30	19–17	Sand, coarse and fine gravel, broken shells.		2		8			24	7
D 5702	"	13–12¾	Trawl contained chiefly shells with a few fair-sized stones.			2	5			12	7
D 5705	Feb. 6	9–9	Soft, gray mud, filled with worm tubes and ophiurans, very evident grit.			1	15	1			9
D 5706	"	9–7	Fine, semi-liquid mud, brownish gray, with black sticky lumps, very little grit, fewer worm tubes than 5705.								2
D 5707	"	8–9¾	Bottom not accurately determined.				3			2	4
D 5708	"	10½–12¾	Sandy mud.				3			1	1
D 5709	"	12½–10	Muddy sand.				3				3
D 5710	Feb. 16	16–9	Shell fragments, cinders, lumps of hard mud, finest ingredients washed out.							11	41
D 5711	"	8½–9¾	Somewhat muddy, coarse sand and shell fragments.				2			24	6
D 5712	"	10½–14¾	Coarse gray sand and shell fragments.				5			29	m
D 5713	"	17–10	Medium, coarse, gray sand with few pebbles.				2			16	8
D 5714	Feb. 28	15–9	Black, sandy mud (sand very fine) and dead shells (mostly *Macoma*).				2				2
Upper											
D 5715	"	9½–13½	Fine, gray, dark sand, followed by soft gray mud almost free from grit.			2	15			4	19
D 5716	"	6–9	Soft, very smooth mud.				5				2
D 5717	"	7–6¾	" " " "				3				
Middle											
D 5718	"	7½–9	Soft, gray mud with great quantities of worm tubes and ophiurans.								
Upper											
D 5719	Mar. 1	6½–6	Soft mud, with lumps of hard sticky mud, almost free from grit.				m				m
D 5720	"	14¾–11	Soft mud and muddy sand, apparently taken separately.				5				m
D 5721	"	8½–8	Soft mud, partly black, partly brown, with coarse sand, clinkers and some large stones, abundant rotten drift-wood and vegetable debris. Animal life scarce except for crabs, shrimps and barnacles.				11				16

STATIONS DURING THE YEARS 1912 AND 1913

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5700				5							9–foot Agassiz trawl; net torn.
D 5702				3		2	1				9–foot Agassiz trawl.
D 5705			1			1					5–foot Tanner trawl.
D 5706									1		" " "
D 5707											" " "
D 5708	2		10	1		1					9–foot Agassiz trawl.
D 5709	3							1			*Pinnixa littoralis* 1.
D 5710						1					5–foot Tanner trawl. 5–foot Tanner trawl.
D 5711											" " "
D 5712						1					" " "
D 5713						1					" " "
D 5714	1					14					" " "
D 5715						4		1	1		" " "
D 5716	2					10	1				" " "
D 5717	2					10					" " "
D 5718				1		18			1		" " "
D 5719						10					" " "
D 5720						15					" " "
D 5721						40					9–foot Agassiz trawl.

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Upper	1912	fms.									
D 5722	Mar. 1	5½–4¾	Soft, sticky mud, black and brown, without grit, containing shells of *Mya*.				2				
Lower											
D 5723	Mar. 6	9½–11	Black, sticky mud, streaked with brown, many shells, clinkers. Fish probably lost, as none were taken. Abundant ophiurans.			20	2				1
D 5724	"	8¾–9½	Soft, dark mud, somewhat gritty, with very few shell fragments.								
D 5725	"	7½–7	Soft, dark, somewhat gritty mud.								8
D 5726	Mar. 8	6¾–7¼	Soft, black, slightly sandy mud.			1					2
D 5727	"	6¼–5¼	Soft, black, sticky mud.				8				
D 5729	"	4¾–4¾	Sticky, nearly black mud, comparatively small quantities of shells and shell fragments.				18			1	3
D 5730	"	5–5¼	Sticky, black mud, with very little grit.			3	18				6
Outside											
D 5731	Mar. 11	16–9¾	Coarse sand with pebbles and shell fragments.				1			m	m
D 5732	"	11¾–9¼	Coarse sand and gravel, ranging up to about 2 cm. Most of sand sifted out, leaving coarse gravel. Thus, bottom sample not representative.			1	1			m	16
D 5733	"	9–8	Fine, dark, very clean sand.				2			m	9
D 5734	"	7¾–9½	" " "								
D 5735	"	9¾–10	" " "				4			38	40
D 5736	"	9¾–10	" " "				1	1		23	7
D 5737	"	10½–13	" " "				10			34	m
Middle											
D 5738	Mar. 13	60–23	Large rocks with very little coarse shelly sand.		3		2				
D 5739	"	18–22	Sand, followed by sandy mud.			1	4				9
D 5740	"	7–5	Fine, gray sand, followed by smooth gray-green mud.								
D 5741	Mar. 18	19¼–18	Clean, dark-gray medium coarse sand and fine shell fragments, with a few fragments of stone. Little life; no perfect shells.							2	2
D 5742	"	20½–20	Bottom similar to last, but containing occasional small compact masses of black mud.				3			16	35

STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D. 5722	.....	.....	.....	.....	.....	9	.....	.....	.....	.....	9–ft. Agassiz trawl
D 5723	.....	.....	1	6	.....	.....	.....	1	1	.....	5–foot Tanner trawl.
D 5724	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	9–foot Agassiz trawl; beam trawl carried away; too much mud.
D 5725	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	5–foot Tanner trawl.
D 5726	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9–foot Agassiz trawl.
D 5727	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	9–foot Agassiz trawl; trawl net carried away but most of contents saved.
D 5729	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9–foot Agassiz trawl.
D 5730	1	.....	.....	.....	.....	.....	.....	.....	.....	1	" " "
D 5731	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	" " "
D 5732	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	" " "
D 5733	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	" " "
D 5734	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	" " "
D 5735	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	" " "
D 5736	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5737	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5738	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9–foot Agassiz trawl; net badly torn.
D 5739	.....	.....	.....	.....	.....	14	.....	.....	.....	.....	5–foot Tanner trawl.
D 5740	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	5–foot Tanner trawl; net badly torn.
D 5741	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	9–foot Agassiz trawl.
D 5742	.....	.....	.....	.....	.....	3	8	.....	.....	.....	" " "

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Middle	1912	fms.									
D 5743	Mar. 18	10–15½	Muddy sand (latter so fine as to pass through finest screen of table sieve). Large amount of bottom material landed and an unusually large quantity of living worms, molluscs and brittle stars.	.....	.....	2	m	.....	.....	.....	m
D 5744	"	5½–5	Soft, slightly sandy mud, with great quantities of worm tubes.	....		1	48	....	..		10
D 5745	"	14½–12½	Dark-gray sand which did not pass through finest screen of table-sieve, with small masses of black mud and considerable vegetable debris and shells.	..		1	m	.		7	m
D 5746	"	18–18	Dark-gray sand which did not pass through the finest screen of table sieve, pebbles, shell fragments, a little mud.	.....	.....	1	7	.....	.....	4	47
D 5747	Mar. 19	ft. 4–fms. 5	Dark, sticky mud, slightly gritty streaked with yellowish.	.....	.....	2	8	.....	.....	.....	41
D 5748	"	ft. 4–fms. 5	Bottom much as in 5747.	.....	.....	3	1	.....	.....	.....	2
D 5749	"	ft. 5–fms. 5	Very dark, sticky mud, slightly gritty, with many dead shells and shell fragments.	....	....	....	4	..	..		12
D 5750	Mar. 20	ft. 5–fms. 5	....	....		....	5	..	..	.	4
D5751	,,	ft. 4½–fms. 5	. . . . .		.	..	2	..	..	....	43
Upper											
D 5752	"	ft. 5–fms. 5½	Very liquid yellow or brown-gray mud, slightly gritty, with numerous particles of vegetable debris.	....	..	....	..	.....	.....	....	1
Middle											
D 5753	"	ft. 6–fms. 5	A little mud of character of that in 5752.	..		....	..	...	....	.....	6
D 5754	Mar. 25	fms. 1¼ ft. 3½	Brown mud, slightly gritty and not very sticky.	.	..	1	37	...	....	....	45
D 5755	"	fms. 3½–ft. 5	Fine, dark-gray, slightly muddy sand with shell fragments.	....	....	2	35	.....	.....	.....	32

STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5743	.....	.....	.....	.....	.....	10	.....	1	.....	.....	9–foot Agassiz trawl.
D 5744	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	" " "
D 5745	.....	.....	.....	.....	.....	16	.....	.....	.....	.....	" " "
D 5746	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5747	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Dredged with launch in both directions, using 19–inch boat dredge and 3–foot Tanner trawl.
D 5748	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5749	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	" " "
D 5750	.....	.....	.....	.....	.....	2	.....	.....	.....	1	" " "
D 5751	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5752	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	" " "
D 5753	.....	.....	1	.....	.....	1	.....	.....	.....	.....	" " "
D 5754	.....	.....	.....	1	.....	2	.....	.....	.....	.....	" " "
D 5755	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	" " "

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Middle	1912	fms.									
D 5756	Mar. 26	4½–2	Soft gray mud, with abundant vegetable debris.								4
Upper											
D 5757	"	fms. 4–ft. 4½	Fine, grayish-black, very muddy sand.				8				4
D 5758	"	fms. 2–ft. 4	Bottom as in 5756.				4				15
D 5759	April 1	fms. 4–3½	Dark gray, sticky mud, without grit or much vegetable debris.								11
D 5760	April 2	fms. 2½–ft. 3	Hard, clean, dark-gray sand, with mica flakes.								1
D 5761	"	fms. 3–5	Soft, muddy sand, or sandy mud, with driftwood fragments and other vegetable debris.								4
Middle											
D 5762	April 3	3½–3¼	Rock fragments, little or no sand.			1	1				
D 5763	"	2–5½	No bottom sample taken, as eel grass did not permit dredge to scrape bottom.				20				1
D 5764	"	4¾–2½	Bottom as in 5763.				17				3
D 5765	"	1¾–2½	Sand.				4			1	
Lower											
D 5766	April 8	3–4	Fine, gray, non-gritty, liquid mud.			2	47				m
D 5767	April 9	3–1¾	Muddy sand.			4	m				m
D 5768	"	3½–1¾	Hard shelly bottom; living and dead *Mytilus* and *Monia* very numerous.			17	30				5
Middle											
D 5769	April 15	3¼–3	Hard sand? (No bottom sample taken).							m	
D 5770	"	5–7½	Rough, rocky bottom. (No bottom sample taken).				4				

STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5756	1	.....	1	.....	.....	.....	.....	.....	.....	.....	Dredged with launch in both directions, using 19–inch boat dredge and 3–foot Tanner trawl.
D 5757	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	" " "
D 5758	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5759	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5760	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5761	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5762	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	" " "
D 5763	.....	.....	7	1	.....	5	.....	.....	.....	.....	*Spirontocaris paludicola* 1. Dredged with launch 19–inch boat dredge and 3–foot beam trawl. (Bottoms dredged are indicated on chart by black lines, the remainder of the run by the dotted lines).
D 5764	.....	.....	3	.....	.....	2	.....	.....	.....	.....	Launch used as in 5763. (Continuous and dotted line have same significance as above).
D 5765	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	Launch used as in 5763 and 5764. (See note under preceding station).
D 5766	1	.....	3	.....	.....	2	.....	.....	.....	11	Dredged with launch in both directions, using 19–inch boat dredge, and 3–foot Tanner trawl, (Dredged up San Antonio Creek, Oakland, with boat dredge; came back with trawl).
D 5767	.....	.....	.....	1	.....	.....	.....	.....	.....	2	Dredged with launch in both directions, using 19–inch boat dredge and 3–foot Tanner trawl.
D 5768	.....	.....	1	.....	.....	.....	.....	.....	.....	m	Dredged with launch in both directions, using 19–inch boat dredge.
D 5769	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Dredged with launch in both directions, using 19–inch boat dredge and 3–foot Tanner trawl.
D 5770	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*Spirontocaris franciscana* 3. *Spirontocaris taylori* 2. Apparatus as before.

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Middle	1912	fms.									
D 5771	April 15	3¼–ft. 3	Thin, dark-colored mud, not sticky and not gritty.	.....	.....	.....	7	.....	.....	.....	2
D 5772	"	fms. 1¼–4½	Soft mud, with numerous worm tubes. No sample saved.	.....	.....	1	22	.....	.....	.....	1
D 5773	"	3½–2¾	Rocky, the sample consisting of angular stones of various sizes.	.....	.....	2	7	.....	.....	.....	4
D 5774	April 16	4½–4¼	Large, angular stones, covered with barnacles and bryozoa, interspersed with rounded gravel.	.....	.....	.....	1	.....	.....	.....	.....
D 5775	"	7–4	Large and small angular rock fragments.	.....	.....	.....	.....	.....	.....	.....	.....
D 5776	April 17	3½-3¼	Fine, clean gray sand, between rocks.	.....	.....	.....	29	.....	.....	m	.....
D 5777	"	3½-2¾	Large, rounded weedy rocks.	.....	.....	.....	28	.....	.....	16	1
D 5778	"	3¾–2¼	Fine, clean, gray sand and medium sized rounded stones.	.....	.....	1	m	1	.....	28	.....
D 5779	May 8	3–3	Dark gray sand, rounded stones and small boulders	.....	.....	16	m	1	.....	.....	27
Upper											
D 5780	May 13	5–1	Sticky, dark gray mud, without sand, mixed in latter part of course with abundantly broken shells (mud samples taken at both ends.)	.....	.....	.....	7	.....	.....	.....	m
Lower											
D 5781	May 27	fms. 2½–ft. 3	Mud first, then shelly, after entering oyster beds.	.....	.....	.....	11	.....	.....	.....	.....
D 5782	"	4–4	Shelly.	.....	.....	.....	2	.....	.....	.....	.....
D 5783	May 28	fms. 2–2	.....	.....	.....	.....	3	.....	.....	.....	.....
D 5784	"	1½–1¾	.....	.....	.....	.....	13	.....	.....	.....	2
Outside											
D 5785	Oct. 15	39–40	Little bottom material taken, most of it having passed through meshes of net (that taken was very fine, dark-green sand).	5	.....	.....	.....	.....	22	.....	.....
D 5786	"	40–40	Very fine, dark-green sand.	m	.....	.....	.....	.....	m	.....	.....
D 5787	"	40 41	" " "	7	.....	.....	.....	.....	m	.....	.....

STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5771											Apparatus as before.
D 5772								1			" " "
D 5773			2	4							*Crago munitella* 2. Apparatus as before.
D 5774											Apparatus as before.
D 5775											*Crago munitella* 1. *Scleroplax granulata* 1. Apparatus as before.
D 5776						4					Apparatus as before.
D 5777											*Spirontocaris taylori* 2. Apparatus as before.
D 5778			1	1	1	3				2	*Spirontocaris franciscana* 1. *Spirontocaris brevirostris* 1. *Spirontocaris taylori* 6. *Epialtus productus* 1. Apparatus as before.
D 5779			1	1		3					Apparatus as before.
D 5780						3					" " "
D 5781			1							29	19-inch boat dredge. (In an unused oyster bed).
D 5782										33	19-inch boat dredge. (Made a circle in oyster bed and finished at starting point).
D 5783											19-inch boat dredge.
D 5784						1				2	" " "
D 5785		32					2				*Spirontocaris gracilis* 16. *Pinnixa occidentalis* 1. 12-foot Agassiz trawl. (On fishing grounds).
D 5786		13									*Spirontocaris gracilis* 1. Apparatus as before.
D 5787		24									*Paguristes bakeri* 1. Apparatus as before.

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Outside	1912	fms.									
D 5788	Oct. 21	68–60	Very fine, green sand.	m	.....	.....	.....	.....	2	.....	.....
D 5789	"	46–33	" " "	18	.....	.....	.....	.....	35	.....	.....
D 5790	Oct. 22	35–33	Very coarse variegated sand, with a small proportion of fine sand.	1	.....	.....	.....	.....	m	.....	.....
D 5791	"	36–29	Refuse and garbage, but little bottom material.	m	.....	2	.....	.....	32	.....	.....
D 5792	"	26–19	Fine, dark gray, somewhat greenish sand.	.....	.....	.....	1	15	20	1	.....
Upper											
D 5793	Oct. 28	10–14	Black, sticky mud, with grayish brown sand.	.....	.....	.....	4	.....	.....	.....	3
D 5794	"	14½–11	Dark gray sticky mud, with brown sand.	...	...	...	24	..	.....	...	8
Middle											
D5795	Oct. 29	13–19	Stones (one measuring 8 inches).	.....	.....	2	42	1	.....	19	14
D5796	"	19–13½	Sand, with abundant shells and shell fragments.	.....	.....	.....	9	.....	.....	28	18
D 5797	"	8½–7½	Sand.	.....	.....	.....	m	3	.....	.....	m
D 5798	"	8–7½	Mud.	.....	.....	.....	m	.....	.....	1	m
D 5799	"	8½–12½	Very fine, very muddy sand.	.....	.....	1	m	20	.....	1	m
D 5800	"	16½–16½	Coarse sand and stones.	.....	.....	.....	1	.....	.....	4	2
D 5801	"	16½–17	Gravel, stones, sand.	.....	.....	.....	16	.....	.....	9	.....
Lower											
D 5802	Oct. 30	10–10¼	Sandy, shelly mud.	.....	.....	43	m	.....	.....	1	m
D 5803	"	9½–8	Soft mud.	.....	.....	3	m	10	.....	.....	m
D 5804	"	7½–6¾	Soft mud and worm tubes.	.....	.....	.....	m	3	.....	.....	m
D 5805	"	5½–5	" " "	.....	.....	.....	m	1	.....	.....	m
Outside											
D 5806	Nov. 4	14¼–13	Fine, dark gray, fairly clean sand.	.....	.....	.....	6	4	.....	3	m
D 5807	"	8½–9	.....	.....	.....	2	3	.....	.....	46	4
Middle											
D5808	"	43–27	Coarse sand, gravel and stones ranging up to 14 inches in length.	.....	23	.....	m	.....	.....	3	2

STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5788											*Crago communis* 25. *Crago resima* 3. *Crago spinosissima* 2. *Paguristes turgidus* 2. *Pinnixa occidentalis* 1. 12-foot Agassiz trawl.
D 5789		31									*Crago spinosissima* 3. *Paguristes turgidus* 1. *Paguristes bakeri* 2. *Pinnixa occidentalis* 1. Apparatus as before.
D 5790		21									*Crago alba* 8. *Pylopagurus minimus* 1. *Paguristes bakeri* 1. *Cancer gibbosulus* 3. Apparatus as before.
D 5791		8									*Spirontocaris gracilis* 3. Apparatus as before.
D 5792		40									Apparatus as before.
D 5793											Heavy oyster dredge.
D 5794											" " "
D 5795				3		2					*Spirontocaris brevirostris* 1. Apparatus as before.
D 5796						3					Apparatus as before.
D 5797							3				5-foot sledge trawl.
D 5798						1	3				" " "
D 5799						1	7				" " "
D 5800											Heavy oyster dredge.
D 5801				1		13					" " "
D 5802				1		5	5				5-foot sledge trawl.
D 5803										1	" " "
D 5804						1					" " "
D 5805											" " "
D 5806		2				8					*Paguristes turgidus* 2. 12-foot Agassiz trawl.
D 5807						7					Apparatus as before.
D 5808				3	1	13					Oyster dredge.

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Middle	1912	fms.									
D5809	Nov. 4	53–21½	Coarse sand, gravel and stones.	.....	3	1	48	.....	.....	2	.....
Lower											
D 5810	Nov. 11	1¾–1¼	Mud and shells.	.....	.....	.....	.....	.....	.....	.....	.....
D 5811 A, B + C	"	1–½	" " "	.....	.....	.....	.....	.....	.....	.....	.....
D 5812 A and B	Nov. 27	1	" " "	.....	.....	.....	.....	.....	.....	.....	.....
D 5813	"	1½	" " "	.....	.....	.....	.....	.....	.....	.....	.....
D 5814 A and B	"	1–1¼	" " "	.....	.....	.....	.....	.....	.....	.....	.....
Upper											
D 5815	Dec. 9	7–13	Somewhat sandy mud, vegetable fragments and fine flakes of mica, at beginning and fine, muddy sand, vegetable debris and shell fragments, at end of haul.	.....	.....	.....	34	.....	.....	.....	m
D 5816	"	9½–10½	Tenacious mud, mainly free from sand, black with yellow layer on top, and streaked throughout; many large shells of *Mya* with surface stained black, at beginning and tenacious mud, mainly dark, with yellow coating at surface, streaked throughout and containing flakes of mica, at end of haul.	.....	.....	.....	m	.....	.....	.....	m
D 5817	"	5½	Clear and sandy mud, at beginning and stiff mud, yellow at surface and streaked with sand, at end of haul.	.			m		..		m
D 5818	Dec. 10	5½–4¾	Somewhat gritty black mud, slightly micaceous, with yellow surface layer; practically no life, at beginning and very sandy, gray and black micaceous mud, at end of haul.	.....	.....	.....	m	.....	.....	.....	m
D 5819	"	7–6	Bottom much like preceding, but semi-fluid and somewhat less sandy.	.....	.....	.....	m	.....	.....	.....	m
D 5820	"	12½–8	Bottom as before, but more sandy than at preceding stations.	.....	.....	.....	m	.....	.....	33	m
Middle											
D 5821	Dec. 17	8–9¾	Sandy mud and muddy sand with little tenacity, a few broken shells and many shell fragments. Very little life.	.....	.....	.....	m	4	.....	.....	m

STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5809						7					Oyster dredge.
D 5810										38	Oyster tongs; (in Darbee-Immel oyster beds, 3 spots).
D 5811										17	Oyster tongs; (Moraghan oyster beds).
D 5812										6	Oyster tongs; (Morgan Oyster Co.'s Dumbarton No. 2 bed, near camp. Company's launch used. A number of oyster specimens taken in two places by means of tongs).
D 5813										1	Oyster tongs; (Morgan Oyster Co's Mowry bed).
D 5814										11	Oyster tongs; (Morgan Oyster Co's South Belmont bed).
D 5815											Orange peel bucket used at each end, sledge trawl through intervening distance.
D 5816						1					" " "
D 5817										2	" " "
D 5818						5					" " "
D 5819						6				1	" " "
D 5820	4										" " "
D 5821											" " "

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Middle	1912	fms.									
D 5822	Dec. 17	5–6	Smooth mud, purer than preceding two lots, at beginning and mud fairly free from sand, more liquid than much of that taken previously, at end of haul.	.....	.....	.....	20	.....	.....	.....	m
D 5823	"	7–10½	Mud rather liquid, like preceding with many much stained shells of *Macoma* and *Cardium*, together with shell fragments.	.....	.....	.....	32	1	.....	.....	m
D 5824	Dec. 18	12½–7	Soft, gray mud, slightly gritty, not very tenacious, at beginning and shelly, somewhat muddy sand, at end of haul.	.....	.....	.....	m	1	.....	.....	m
D 5825	"	8½–12½	Very muddy sand.	.....	.....	.....	m	18	.....	.....	m
D 5826	"	7–9	Dark, fairly clean, medium sand, with shell fragments, at beginning and sand, with a very little mud and many shell fragments, at end of haul.	.....	.....	.....	m	21	.....	10	m
D 5827	1913 Jan. 20	17–6¾	Clean, coarse sand and gravel, stones of all sizes up to width of hand, and ½ inch thick, with many large and small shells and shell fragments, at beginning of haul; sand and fine gravel, but no stones of size taken at end of haul.	.....	1	.....	2	.....	.....	.....	27
D 5828	"	16½–10½	Soft, tenacious mud, slightly sandy, especially in spots, at beginning and mud rather variegated in color and composition, containing some sand and many shells, at end of haul.	.....	1	4	m	3	.....	11	m
D 5829	"	10½–15½	Sand and fine gravel with some shell fragments; a few living molluscs.	.....	.....	1	1	.....	.....	1	.....
D 5830	Jan. 21	11–8½	Fine, uniform dark-grey sand, which washed out very easily, at beginning and tenacious mud, streaked in color, with sandy patches, at end of haul.	.....	.....	.....	m	3	.....	.....	m
Lower											
D 5833	Jan. 27	6½	Sand, shells, cinders and unburned coal.	.....	.....	.....	1	.....	.....	.....	.....
D 5835	Feb. 3	7½	Sandy mud with many shell fragments.	.....	.....	.....	.....	.....	.....	.....	.....
Middle											
D 5845	Apr. 7	33–49	Large stones (about a wash-tub full) ranging to 20 lbs. in weight, several bored by molluscs.	.....	.....	.....	.....	.....	.....	.....	.....

STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5822	1	.....	.....	.....	.....	2	.....	.....	.....	.....	Orange peel bucket used at each end, sledge trawl through intervening distance.
D 5823	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5824	28	.....	.....	.....	.....	.....	.....	1	.....	.....	" " "
D 5825	11	.....	.....	.....	.....	2	1	6	1	.....	" " "
D 5826	.....	.....	1	1	.....	10	8	.....	.....	.....	" " "
D 5827	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5828	.....	.....	.....	.....	.....	1	1	.....	.....	.....	" " "
D 5829	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5830	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5833	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Orange peel bucket.
D 5835	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	" " "
D 5845	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	Heavy oyster dredge, without lining.

List of Species Taken at "Albatross" Dredging

Station No.	Date	Depth	Character of Bottom	Pandalus jordani	Pandalus danae	Spirontocaris cristata	Crago nigricauda	Crago nigromaculata	Crago alaskensis elongata	Crago stylirostris	Crago franciscorum
Lower	1913	fms.									
D 5847	April 22	8½–9	Dark, very tenacious mud, with scarcely any perceptible grit, and of uniform color and consistency, at beginning and black muddy sand, or sandy mud, with a large proportion of shells, at end of haul.	.....	.....	6	m	.....	.....	.....	m
D 5848	"	9–9½	Dark, very tenacious mud, except for thin layer of paler, softer mud at surface, very few shells, at beginning and dark, tenacious, clear mud, with a few patches of sand or fine gravel, a few shells and shell fragments, at end of haul.	.....	.....	45	m	.....	.....	.....	m
D 5849	"	10–9	Mud softer than last, nearly free from sand or shells, at beginning and clear, tenacious dark mud, with a few entire Macoma shells and fragments, at end of haul.	.....	.....	.....	6	.....	.....	.....	.....

STATIONS DURING THE YEARS 1912 AND 1913—(*Concluded*)

Station No.	Callianassa longimana	Pagurus ochotensis	Pagurus hirsutiusculus	Cancer productus	Cancer antennarius	Cancer magister	Cancer gracilis	Pinnixa franciscana	Pinnixa schmitti	Hemigrapsus oregonensis	Addenda (Inclusive of apparatus used).
D 5847	.....	.....	.....	.....	.....	.....	1	.....	.....	1	Orange peel bucket used at each end, sledge trawl through intervening distance.
D 5848	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	" " "
D 5849	.....	.....	.....	.....	.....	.....	1	.....	.....	4	" " "

APPENDIX II B

List of Species Taken at "Albatross" Hydrographic Stations During the Years 1912 and 1913

In order to present the physical data (temperature, salinity, and phase of tide) obtained at such hydrographic stations as are correlated with the dredging stations given in appendix III (p. 354), a number of stations at which no specimens were taken have been included in this table.

The methods and apparatus employed in obtaining these data are fully explained in the report on the physical conditions (Sumner, 1914). Unless otherwise specified, the collecting apparatus consisted of three tow-nets, used simultaneously from the ship's dredging cable and towed just below or within a few feet of the surface. The three nets were a large intermediate (4-foot diameter) net made of No. 000 grit gauze, and two smaller wing-nets with 14-inch diameter hoops covered respectively with No. 12 and No. 20 bolting silk.

The positions of these stations can be readily ascertained by means of the "Reference Station" given in the second column of the table: the H stations there cited are the so-called primary hydrographic stations plotted on plate 4; the D (dredging) stations are plotted on plates 2 and 3. A summary of the hydrographic stations having approximately the same position is given below. The mean depth of all stations whose positions thus approximate has been included in this summary as a matter of record, as the depths of hydrographic stations are not otherwise given in this paper.

Only the four returns most frequent with the tow-nets (*Spirontocaris cristata, Crago nigricauda, C. franciscorum,* and the "crab megalopa") are given in the vertical columns of occurrences; all others, the species more rarely taken, are given in the column of "Addenda." Fifty or more specimens are represented by the letter "m" (many).

SUMMARY OF HYDROGRAPHIC STATIONS HAVING APPROXIMATELY THE SAME POSITION

Primary hydrographic station	Mean depth (all stations)	Hydrographic stations having approximately the same positions as the primary stations.
MIDDLE	fms.	
4967	11.7	5000, 5097, 5120, 5130, 5188, 5218, 5240, 5277, 5297, 5328.
4968	19.5	4999, 5098, 5121, 5131, 5156, 5298, 5327.
4969	19.2	4998, 5099, 5122, 5155, 5190, 5216, 5299, 5326.
4970	8.0	4997, 5133, 5191, 5215, 5237, 5280.
4971	9.9	4996, 5101, 5124, 5134, 5192, 5214, 5236.
4972	8.3	4995, 5102, 5125, 5135, 5193, 5235, 5282.
4973	7.1	4994, 5103, 5126, 5136, 5234, 5283.
4974	7.7	4993, 5104, 5127, 5137, 5150, 5233, 5284.
UPPER		
4975	12.5	4986, 5088, 5111, 5149, 5166, 5179, 5196, 5268, 5291.
4976	8.7	4987, 5087, 5110, 5167, 5178, 5242, 5267.
4977	6.2	4988, 5086, 5109, 5168, 5243, 5266.
4978	5.1	4989, 5085, 5169, 5176, 5199, 5244, 5265, 5288.
4979	6.6	4990, 5084, 5107, 5200, 5264.
4980	6.5	4991, 5083, 5106, 5171, 5246, 5263.
4981	12.5	4992, 5082, 5105, 5146, 5172, 5262, 5330.
LOWER		
5001	6.0	5017, 5096, 5119, 5158, 5187, 5248, 5276, 5313.
5002	5.0	5016, 5095, 5118, 5144, 5159, 5186, 5275, 5311.
5003	4.8	5015, 5117, 5143, 5160, 5185, 5274, 5315.
5004	5.5	5014, 5116, 5161, 5184, 5207, 5251, 5273, 5316.
5005	5.9	5013, 5115, 5162, 5183, 5206, 5252, 5272, 5308, 5317.
5006	8.2	5012, 5114, 5163, 5182, 5205, 5253, 5271.
5007	9.9	5010, 5090, 5113, 5164, 5181, 5204, 5254, 5270, 5306, 5319.
5008	11.5	5009, 5089, 5112, 5138, 5165, 5255, 5269, 5320.

List of Species Taken at "Albatross" Hydrographic Stations During the Years 1912 and 1913

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		*Spirontocaris cristata*	*Crago nigricauda*	*Crago franciscorum*	Crab megalopa	Addenda
				Surface	Bottom	Surface	Bottom					
Middle		1912		C.	C.	‰	‰					
H 4967		Feb. 13	Strong ebb	12.1	12.2	29.53	31.01	..	.			
H 4968		"	"	12.1	12.2	27.59	26.10			..	..	
H 4969		"	"	12.2	13.1	26.49	28.40					
H 4970		"	"	12.1	12.1	26.96	28.46			..	.	
H 4971		"	"	12.1	12.0	26.16	26.32	.	..			
H 4972		"	Ebb	12.0	12.1	23.91	25.39	.	.	.		
H 4973		"	"	12.0	12.0	18.23	22.76	..		.		
H 4974		"	"	12.0	11.9	17.47	21.74		.		..	
Upper												
H 4975		Feb. 15	Strong ebb	12.1	12.0	13.91	18.56	....		..		
H 4976		"	"	12.1	12.0	13.94	17.68	.	.		.	
H 4977		"	"	12.0	12.1	15.10	19.85		..			
H 4978		"	"	12.0	12.2	14.19	21.47	..		.		
H 4979		"	"	12.2	12.2	21.54	22.11	.			.	
H 4980		"	"	12.1	12.2	19.02	21.28	..	.		.	
H 4981		"	"	11.8	12.2	21.41	22.51	.				
Middle												
H 4982	D 5710	Feb. 16	Flood	11.0	.....	. .	. .	...	.	.	...	
H 4983	D 5711	"	"	11.0	.....	. ..			.			
H 4984	D 5712	"	"	11.0	.....	. . .	..	.		.		
Upper												
H 4986	H 4975	Feb. 20	Flood	12.2	12.2	7.01	12.67		..	13		
H 4987	H 4976	"	"	12.3	12.5	13.33	17.40		4	38		Net touched bottom.
H 4988	H 4977	"	"	12.9	12.6	11.35	19.57				..	Full of mud.
H 4989	H 4978	"	Slight flood	12.9	12.7	21.42	21.12	.	5	m		
H 4990	H 4979	"	"	12.8	12.6	24.22	24.19				..	
H 4991	H 4980	"	*Slack water	12.7	12.7	24.03	24.77		.		.	*Changing to fairly strong ebb.
H 4992	H 4981	Feb. 21	Flood, stream slow	12.3	12.6	18.95	23.95				.	
Middle												
H 4993	H 4974	"	Flood	12.4	12.6	22.35	24.19			m		
H 4994	H 4973	"	"	12.6	12.4	23.77	25.35		3	2	.	
H 4995	H 4972	"	"	12.6	12.3	25.20	27.59		3	5	.	
H 4996	H 4971	"	Slow stream	.....	12.7	26.78	29.14	1	m	m	..	*Spirontocaris* young 1. *Crago stylirostris* 1. *Callianassa longimana* 1.

LIST OF SPECIES TAKEN AT "ALBATROSS" HYDROGRAPHIC STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		Spirontocaris cristata	Crago nigricauda	Crago franciscorum	Crab megalopa	Addenda
				Surface	Bottom	Surface	Bottom					
MIDDLE		1912		C.	C.	‰	‰					
H 4997	H 4970	Feb. 21	Slow stream	12.9	12.3	.....	28.74	.....	.....	.....	1	
H 4998	H 4969	"	"	12.5	12.2	28.40	28.92	.....	1	13	2	
H 4999	H 4968	"	"	12.5	12.2	28.23	28.14	.....	.....	19	1	
H 5000	H 4967	"	Slack	12.2	12.2	31.00	31.18	.....	.....	.....	.....	
LOWER												
H 5001	.....	Feb. 23	*Flood	12.3	12.4	28.53	27.30	.....	.....	.....	.....	*Moderate current.
H 5002	.....	"	"	12.6	12.6	28.56	28.40	.....	.....	40	.....	
H 5003	.....	"	"	12.7	12.6	28.29	28.33	.....	.....	38	.....	
H 5004	.....	"	"	12.7	12.6	28.14	28.02	.....	1	23	.....	
H 5005	.....	"	"	12.7	12.6	27.87	27.83	1	.....	4	.....	*Crago stylirostris* 1.
H 5006	.....	"	Flood, slow stream	12.5	12.8	27.48	27.52	.....	.....	1	.....	Mud haul.
H 5007	.....	"	"	12.4	12.2	26.94	27.17	.....	.....	12	.....	
H 5008	.....	"	"	12.6	12.0	27.68	27.85	.....	.....	2	.....	
H 5009	H 5008	Feb. 27	Swift ebb (at outset)	11.4	10.8	27.37	28.84	.....	.....	.....	.....	
H 5010	H 5007	"	Ebb	11.6	11.4	27.01	27.72	2	.....	m	.....	
H 5012	H 5006	"	"	11.8	11.6	27.81	27.65	.....	.....	15	.....	
H 5013	H 5005	"	"	11.7	11.7	27.79	27.75	.....	9	m	.....	
H 5014	H 5004	"	"	11.6	11.6	28.11	28.12	.....	2	46	.....	
H 5015	H 5003	"	"	11.7	11.6	28.23	28.28	1	.....	4	.....	*Crago stylirostris* 1.
H 5016	H 5002	"	"	11.6	11.6	28.28	28.25	.....	.....	3	.....	
H 5017	H 5001	"	"	11.3	11.5	28.38	28.33	.....	.....	4	.....	
UPPER												
H 5082	H 4981	April 23	"	13.2	12.2	13.83	22.68	.....	6	20	.....	
H 5083	H 4980	"	"	13.0	12.7	16.17	.....	.....	5	49	.....	
H 5084	H 4979	"	"	13.4	13.2	13.13	.....	.....	m	m	14	
H 5085	H 4978	"	"	13.4	13.3	.....	8.09	.....	.....	m	.....	
H 5086	H 4977	"	"	13.4	13.7	4.15	7.79	.....	.....	11	.....	
H 5087	H 4976	"	Flood	13.3	13.3	3.75	9.71	.....	.....	46	.....	
H 5088	H 4975	"	"	13.4	13.4	3.25	9.03	.....	.....	16	.....	
LOWER												
H 5089	H 5008	April 26	Ebb	12.9	11.6	25.85	29.06	.....	.....	1	.....	
H 5090	H 5007	"	"	12.6	12.0	26.55	27.79	.....	.....	3	.....	
H 5091	H 5006	"	"	13.2	12.7	26.21	26.39	2	1	m	.....	
H 5092	H 5005	"	"	13.2	12.9	24.85	.....	.....	1	19	.....	

List of Species Taken at "Albatross" Hydrographic Stations During the Years 1912 and 1913—(*Continued*)

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		*Spirontocaris cristata*	*Crago nigricauda*	*Crago franciscorum*	*Crab megalopa*	Addenda
				Surface	Bottom	Surface	Bottom					
Lower		1912		C.	C.	‰	‰					
H 5093	H 5004	April 26	Ebb	13.2	13.8	.....	27.01	.....	.....	m	.....	
H 5094	H 5003	"	"	14.2	13.9	27.17	27.08	1	3	49	1	
H 5095	H 5002	"	"	14.0	13.9	27.17	.....	.....	.....	m	.....	
H 5096	H 5001	"	"	14.2	13.9	26.87	27.31	.....	.....	m	.....	
Middle												
H 5097	H 4967	April 29	"	11.1	11.0	31.36	31.61	.....	.....	.....	1	
H 5098	H 4968	"	"	11.8	11.0	30.02	31.16	3	2	3	1	
H 5099	H 4969	"	"	12.0	11.1	29.95	30.79	1	.....	.....	.....	
H 5101	H 4971	"	"	12.3	11.6	26.71	29.89	1	12	7	2	
H 5102	H 4972	"	"	12.7	12.1	25.30	27.48	1	.....	5	1	
H 5103	H 4973	"	"	13.0	12.3	23.31	26.39	.....	1	47	.....	
H 5104	H 4974	"	"	13.0	12.9	22.29	23.64	.....	9	m	1	
Upper												
H 5105	H 4981	April 30	Flood	13.1	12.7	19.75	23.29	.....	2	m	1	
H 5106	H 4980	"	"	13.1	12.8	19.96	22.05	.....	5	m	3	
H 5107	H 4979	"	"	13.3	12.8	18.95	21.89	.....	6	m	.....	
H 5109	H 4977	"	"	13.8	13.7	14.00	14.00	.....	7	m	1	
H 5110	H 4976	"	"	13.7	13.8	12.45	14.29	.....	1	m	.....	
H 5111	H 4975	"	"	14.2	13.9	9.96	13.35	.....	3	m	.....	
Lower												
H 5112	H 5008	May 1	"	12.6	12.6	26.58	27.89	2	7	m	9	
H 5113	H 5007	"	"	12.7	12.7	27.33	27.85	.....	2	26	.....	
H 5114	H 5006	"	"	13.0	13.1	27.26	27.79	.....	4	20	1	
H 5115	H 5005	"	"	13.2	13.3	27.01	27.01	1	3	m	9	
H 5116	H 5004	"	"	13.6	13.8	27.17	27.01	.....	8	9	.....	
H 5117	H 5003	"	"	14.2	14.3	27.01	27.01	1	1	3	1	
H 5118	H 5002	"	"	14.2	14.3	26.87	27.01	.....	1	.....	.....	
H 5119	H 5001	"	"	14.0	13.9	26.87	26.78	.....	.....	.....	.....	
Middle												
H 5120	H 4967	May 6	"	13.5	12.9	26.55	27.79	1	2	6	.....	
H 5121	H 4968	"	"	13.4	12.6	22.99	.....	.....	.....	.....	.....	
H 5122	H 4969	"	"	14.6	12.3	20.82	28.88	.....	2	11	4	*Spirontocaris* young 1.
H 5123	H 4970	"	"	14.8	12.6	19.70	28.88	1	.....	27	2	
H 5124	H 4971	"	"	13.9	13.0	18.34	27.33	.....	2	39	1	*Callianassa longimana* 1.
H 5125	H 4972	"	"	14.4	13.1	21.60	27.21	.....	1	3	1	

LIST OF SPECIES TAKEN AT "ALBATROSS" HYDROGRAPHIC STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		Spirontocaris cristata	Crago nigricauda	Crago franciscorum	Crab megalopa	Addenda
				Surface	Bottom	Surface	Bottom					
MIDDLE		1912		C.	C.	‰	‰					
H 5126	H 4973	May 6	Flood	13.9	13.2	23.08	27.33	.....	.....	7	1	
H 5127	H 4974	"	"	14.3	13.2	20.66	26.55	.....	5	14	1	
H 5128	*	May 14	"	12.2	12.2	28.79	29.34	1	.....	1	28+	*Between Alcatraz Isl., and H 4967.
H 5130	H 4967	July 22	Ebb	14.3	14.3	31.05	31.36	.....	.....	.....	20+	
H 5131	H 4968	"	"	15.9	14.4	29.47	31.10	.....	.....	3	.....	
H 5133	H 4970	"	"	17.0	14.8	27.54	30.98	.....	.....	.....	10	
H 5134	H 4971	"	"	18.1	14.8	24.39	30.33	1	.....	m	25+	
H 5135	H 4972	"	"	18.2	15.8	28.07	28.88	.....	.....	.....	15+	*Cancer antennarius* 2.
H 5136	H 4973	"	"	17.8	16.0	27.21	28.79	.....	.....	.....	2	
H 5137	H 4974	"	"	17.6	16.0	25.49	28.56	.....	.....	19	.....	*Cancer antennarius* 1.
LOWER												
H 5138	H 5008	July 23	"	17.0	15.0	28.14	30.37	43	9	31	.....	
H 5143	H 5003	"	"	18.4	18.3	27.70	27.59	.....	1	31	.....	
H 5144	H 5002	"	"	18.5	18.3	27.74	27.68	.....	4	40	.....	
UPPER												
H 5146	H 4981	July 24	"	17.3	.....	26.39	28.79	.....	3	29	.....	
H 5149	H 4975	"	"	19.3	18.9	15.16	18.63	.....	.....	m	.....	
MIDDLE												
H 5150	H 4974	July 29	Flood	17.9	17.2	22.32	26.49	.....	.....	48	.....	
H 5155	H 4969	"	"	15.8	14.9	28.95	30.50	.....	.....	10	.....	
H 5156	H 4968	"	"	14.6	14.4	30.96	30.98	.....	.....	11	.....	
LOWER												
H 5158	H 5001	July 30	"	19.3	19.4	27.85	27.87	.....	9	42	.....	
H 5159	H 5002	"	"	19.2	19.3	27.91	27.82	.....	.....	m	.....	
H 5160	H 5003	"	"	18.7	18.8	27.94	27.87	.....	.....	m	.....	
H 5161	H 5004	"	"	17.8	17.7	28.33	28.33	.....	1	m	.....	
H 5162	H 5005	"	"	17.7	17.0	28.49	28.79	.....	.....	19	.....	
H 5163	H 5006	"	"	17.4	17.4	28.51	28.64	1	29	m	.....	
H 5164	H 5007	"	"	16.5	16.4	29.10	29.18	.....	9	m	.....	
H 5165	H 5008	"	"	15.9	14.9	30.11	30.83	2	6	22	.....	
UPPER												
H 5166	H 4975	July 31	"	18.3	18.7	9.96	12.89	.....	.....	m	.....	
H 5167	H 4976	"	"	18.4	18.6	11.35	16.11	.....	.....	m	.....	
H 5168	H 4977	"	"	18.6	18.7	16.63	16.94	.....	1	48	.....	*Cancer magister* 2.
H 5169	H 4978	"	"	18.3	18.3	21.91	22.05	.....	2	10	.....	
H 5171	H 4980	"	"	17.2	16.9	26.47	27.01	.....	.....	7	.....	

List of Species Taken at "Albatross" Hydrographic Stations During the Years 1912 and 1913—(*Continued*)

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		*Spirontocaris cristata*	*Crago nigricauda*	*Crago franciscorum*	*Crab megalopa*	Addenda
				Surface	Bottom	Surface	Bottom					
Upper		1912		C.	C.	‰	‰					
H 5172	H 4981	July 31	Flood	17.0	15.9	28.25	29.23	.....	2	9	.....	
H 5173	H 4981	Oct. 7	Ebb	16.3	15.4	30.20	31.09	.....	.....	1	.....	
H 5176	H 4978	"	"	16.9	16.4	21.24	26.99	.....	.....	6	.....	No. 20 came up muddy.
H 5178	H 4976	"	"	17.1	16.9	18.02	18.34	.....	.....	4	.....	
H 5179	H 4977	"	"	17.1	16.6	20.78	21.21	.....	.....	m	.....	
Lower												
H 5180	H 5008	Oct. 8	"	14.3	14.0	32.21	32.60	.....	.....	16	.....	
H 5181	H 5007	"	"	15.4	14.2	31.89	32.45	.....	.....	9	.....	
H 5182	H 5006	"	"	15.5	15.4	31.36	31.66	.....	.....	1	.....	
H 5183	H 5005	"	"	16.6	16.0	31.27	31.36	.....	.....	2	.....	
H 5184	H 5004	"	"	17.2	17.2	31.29	31.27	.....	.....	.....	.....	
H 5185	H 5003	"	"	17.4	17.2	31.60	31.36	.....	.....	7	.....	
H 5186	H 5002	"	"	17.2	17.0	31.27	31.33	1	20	40	.....	
H 5187	H 5001	"	"	17.0	16.6	31.44	31.36	.....	2	26	.....	As grit gauze lining ripped, outer bag was used as an inter townet (1 in. mesh) at this station.
Middle												
H 5188	H 4967	Oct. 9	"	13.2	12.7	33.22	33.27	1	.....	6	.....	
H 5190	H 4969	"	"	14.4	13.7	32.80	32.60	.....	.....	1	.....	
H 5191	H 4970	"	"	14.4	13.9	32.83	32.60	.....	.....	.....	.....	
H 5192	H 4971	"	"	14.8	13.9	32.28	32.67					
H 5193	H 4972	"	"	14.9	14.3	31.90	32.27	.....	1	41	.....	
Upper												
H 5196	H 4975	Oct. 10	Flood	16.2	16.1	14.03	17.08	.....	1	8	.....	
H 5199	H 4978	"	"	16.0	16.0	24.77	25.16	.....	1	m	.....	
H 5200	H 4979	"	"	15.8	15.4	28.26	28.95	.....	.....	4	.....	
Lower												
H 5204	H 5007	Oct. 11	"	16.0	15.9	31.51	31.51	.....	.....	.....	.....	
H 5205	H 5006	"	"	16.6	16.6	31.36	31.36					
H 5206	H 5005	"	"	16.6	16.6	30.89	31.05					
H 5207	H 5004	"	"	16.7	16.6	31.18	30.91					
Middle												
H 5214	H 4971	Oct. 12	"	14.1	14.2	31.53	31.66	.....	.....	.....	.....	
H 5215	H 4970	"	"	14.7	14.3	31.12	31.66	.....	.....	.....	.....	
H 5216	H 4969	"	"	19.4	13.6	32.08	32.18	3	.....	.....	.....	
H 5217	H 4968	"	"	13.8	13.4	32.29	31.99	.....	.....	.....	.....	*Spirontocaris* young 1.
H 5218	H 4967	"	"	13.2	13.4	33.06	52.33	.....	.....	1	.....	

LIST OF SPECIES TAKEN AT "ALBATROSS" HYDROGRAPHIC STATIONS DURING THE YEARS 1912 AND 1913—(*Continued*)

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		Spirontocaris cristata	Crago nigricauda	Crago franciscorum	Crab megalopa	Addenda
				Surface	Bottom	Surface	Bottom					
OUTSIDE		1912		C.	C.	‰	‰					
H 5219	D 5785	Oct. 15	Ebb	12.0	9.8	33.81	34.14					
H 5220	D 5787	"	Flood	12.2	11.8							
H 5221	D 5788	Oct. 21	Ebb	11.3	9.3	34.16	33.99					
H 5222	D 5789	"	"	11.4	9.4	34.16	34.31					
H 5223	D 5790	Oct. 22	Ebb	11.5		33.89						
H 5224	D 5791	"	"	11.3	9.8	33.87	34.27					
H 5225	D 5792	"	"	11.0		34.08						
H 5226	D 5806	Nov. 4	"	12.2	11.0	33.09	34.03					Vertical tow-net haul.
H 5227	D 5807	"	"	12.2	11.9	32.81	32.93					"
MIDDLE												
H 5228	D 5808	"	"							2		"
LOWER												
H 5229	D 5810	Nov. 11		13.9–14.3	13.4–13.8	31.40–31.42	31.21–31.36					
H 5231 A,B+C	D 5811 A,B+C	"	Ebb	14.2–14.3	14.0–14.4	31.50–31.51	31.44–31.60					
MIDDLE												
H 5233	H 4974	Nov. 25	Flood	12.2	12.4	27.26	28.60					
H 5234	H 4973	"	"	12.1	12.4	26.66	29.82					
H 5235	H 4972	"	"	12.2	12.2	29.10	31.07					
H 5236	H 4971	"	"	12.0	12.2	28.60						
H 5237	H 4970	"	"	12.2	12.2	26.68	30.98					
H 5240	H 4967	"	"	12.0	12.0	32.14	32.28					
UPPER												
H 5241	H 4975	Nov. 26	"	11.8	12.2	14.29	20.38					
H 5242	H 4976	"	"	11.9	12.0	14.62	21.35					
H 5243	H 4977	"	"	12.6	12.3	17.40	22.92					
H 5244	H 4978	"	"	12.4	12.4	22.83	25.62					
H 5246	H 4980	"	Slack	12.6	12 2	25.85	28.26					
LOWER												
H 5248	H 5001	Nov. 27	Flood	13.0	12.9	29.60	30.11					
H 5250	H 5003	"	"	12.9	12.9	28.28	20.16		1	1		
H 5251	H 5004	"	"	12.8	12.8	28.77	28.40		3	m		
H 5252	H 5005	"	"	12.5	12.4	28.72	29.16		4	m		
H 5253	H 5006	"	"	12.5	12.2	29.56	30.11			3		
H 5254	H 5007	"	" (nearly slack)	12.5	12.2	29.43	30.43			4		

List of Species Taken at "Albatross" Hydrographic Stations During the Years 1912 and 1913—(*Continued*)

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		Spirontocaris cristata	Crago nigricauda	Crago franciscorum	Crab megalopa	Addenda
				Surface	Bottom	Surface	Bottom					
Lower		1912		C.	C.	‰	‰					
H 5255	H 5008	Nov. 27	Ebb (beginning)	12.6	12.2	30.35	30.82	.....	.....	2	.....	
H 5256 A and B	D 5812 A and B	"	Flood	12.3	12.4	30.89–31.36	31.27	.....	.....	.....	.....	*Hemigrapsus oregonensis* 1.
H 5257	.....	"	"	.....	.....	.....	.....	.....	.....	21	.....	Tow-net haul between H5256 A, and B.
H 5258	D 5813	"	"	12.7	12.7	31.05	31.18	.....	.....	.....	.....	
H 5260 A and B	D 5814 A and B	"	Ebb	12.8–12.9	12.9	30.11–30.79	30.11–30.74	.....	.....	.....	.....	
Upper												
H 5262	H 4981	Dec. 3	"	11.5	11.7	26.71	28.95	.....	.....	9	.....	
H 5263	H 4980	"	"	11.5	11.7	25.97	28.02	.....	.....	.....	.....	
H 5264	H 4979	"	"	11.5	11.7	24.03	26.32	1	.....	.....	.....	
H 5265	H 4978	"	"	11.5	11.7	17.33	24.52	.....	.....	.....	.....	
H 5266	H 4977	"	"	11.4	11.6	17.47	22.13	.....	.....	9	.....	
H 5267	H 4976	"	"	10.9	11.2	13.75	14.29	.....	.....	44	.....	
H 5268	H 4975	"	"	11.3	11.2	13.37	17.40	.....	.....	.....	.....	
Lower												
H 5269	H 5008	Dec. 4	"	11.3	11.1	29.04	31.12	.....	.....	40	.....	
H 5270	H 5007	"	"	11.6	11.7	29.50	28.88	.....	.....	3	.....	
H 5271	H 5006	"	"	11.8	11.8	29.50	28.56	.....	.....	17	.....	
H 5272	H 5005	"	"	11.8	11.8	29.50	29.50	.....	2	m	.....	
H 5273	H 5004	"	"	12.0	12.1	29.95	29.95	.....	.....	2	.....	
H 5274	H 5003	"	"	12.0	12.0	30.50	29.89	.....	1	15	.....	
H 5275	H 5002	"	"	12.5	11.6	30.20	30.28	.....	.....	9	.....	
H 5276	H 5001	"	"	11.9	12.0	30.43	30.43	.....	1	m	.....	
Middle												
H 5277	H 4967	Dec. 5	"	11.0	11.1	32.28	32.37	.....	.....	.....	.....	
H 5280	H 4970	"	"	11.4	11.3	31.66	31.66	.....	.....	.....	.....	
H 5282	H 4972	"	"	11.4	11.5	30.66	31.21	.....	.....	.....	.....	
H 5283	H 4973	"	"	11.4	11.4	28.40	30.35	.....	.....	.....	.....	
H 5284	H 4974	"	"	11.1	11.4	27.33	29.04	.....	.....	.....	.....	
Upper		1913										
H 5288	H 4978	Jan. 13	"	7.0	6.8	18.56	22.83	.....	.....	2	.....	
Middle												
H 5297	H 4967	Jan. 20	"	8.7	8.8	28.97	29.82	.....	.....	.....	.....	
H 5298	H 4968	"	"	8.7	9.0	29.06	30.74	21	37	m	.....	

LIST OF SPECIES TAKEN AT "ALBATROSS" HYDROGRAPHIC STATIONS DURING THE YEARS 1912 AND 1913—(*Concluded*)

Station No.	Reference Station	Date	Phase of Tide	Temperature		Salinity		Spirontocaris cristata	Crago nigricauda	Crago franciscorum	Crab megalopa	Addenda
				Surface	Bottom	Surface	Bottom					
MIDDLE		1913		C.	C.	‰	‰					
H 5299	H 4969	Jan. 20	Ebb	8.7	8.8	28.56	29.50	7	34	23	.....	
H 5302	H 4972	"	"	8.2	8.3	24.30	25.31	.....	8	m	.....	
LOWER												
H 5306	H 5007	"	"	8.7	8.8	28.02	29.50	.....	.....	1	.....	
H 5308	H 5005	Jan. 21	"	8.1	8.2	27.79	27.94	.....	2	9	.....	
H 5311	H 5002	"	"	7.6	7.7	28.84	29.08	8	1	m	.....	
H 5313	H 5001	Jan. 27	Flood	8.0	8.2	28.56	28.84	.....	.....	16	.....	
H 5315	H 5003	"	"	8.3	10.6	28.02	27.94	.....	.....	12	.....	
H 5316	H 5004	"	"	8.6	8.6	27.33	27.40	.....	.....	6	.....	
H 5317	H 5005	"	"	8.8	8.4	26.62	27.01	2	.....	.....	.....	
H 5319	H 5007	"	"	8.7	8.8	26.10	26.73	4	10	m	.....	
H 5320	H 5008	"	"	9.0	9.0	26.39	28.33	.....	2	9	.....	
MIDDLE												
H 5326	H 4969	Jan. 28	"	8.9	9.4	25.70	28.55	.....	.....	.....	.....	
H 5327	H 4968	"	"	9.0	9.4	26.62	29.50	.....	.....	.....	.....	
H 5328	H 4967	"	"	9.3	9.4	29.04	29.95	.....	.....	.....	.....	
UPPER												
H 5330	H 4981	July 21	"	17.3	16.6	23.80	26.74	.....	.....	4	.....	

APPENDIX II C

1. Shore Collections During the Year 1912

March 1; Sausalito
Cancer gracilis, 1.
March 15; Sausalito; crab-net over ship's side
Cancer antennarius, 1.
March 19; Sausalito Ferry building
Spirontocaris taylori, 5.
Spirontocaris cristata, 3.
Hemigrapsus nudus, 2.
March 23; Sausalito; 150-foot seine
Epialtus productus, 1.
Cancer productus, 1.
Cancer antennarius, 1.
Cancer magister, 3.
Cancer gracilis, 1.
March 30; Sausalito; 150-foot seine
Cancer productus, 1.
Cancer gracilis, 1.
Hemigrapsus nudus, 1.
August 1; Point Bonita, between tide marks
Pagurus hirsutiusculus, 2.
Ocdignathus inermis, 1.
Epialtus productus, 4.
Cancer antennarius, 1.
Cancer gracilis, 1.
Pachygrapsus crassipes, 7.
Hemigrapsus nudus, 11.
Hemigrapsus oregonensis, 4.
August 1; Presidio shore, west of Fort Point
Emerita analoga, 1.
Pachygrapsus crassipes, 1.
Hemigrapsus nudus, 1.
August 2; Key Route pier, piles
Hemigrapsus oregonensis, 12.
August 2; north of Key Route pier
Crago franciscorum, 2.
Cancer magister, 3.
Hemigrapsus nudus, 4.
Hemigrapsus oregonensis, many.
August 3; Red Rock
Pagurus hirsutiusculus, 22.
Pachygrapsus crassipes, 1.
Hemigrapsus nudus, 18.
Hemigrapsus oregonensis, 25.
August 3; Richmond shore, north of Standard Oil pier
Spirontocaris paludicola, 1.
Pagurus hirsutiusculus, 25.
Pagurus samuelis, 1.
Petrolisthes cinctipes, 4.
Cancer magister, 1.
Hemigrapsus nudus, 10.
Hemigrapsus oregonensis, 34.
November 23; Sausalito, near landing
Petrolisthes cinctipes, 1.

2. Shore Collections During the Year 1913

January 18; Sausalito
Pagurus hirsutiusculus, 1.
Hemigrapsus oregonensis, 3.
February 8; Sausalito
Upogebia pugettensis, 1.
February 14; Sausalito
Hemigrapsus oregonensis, 1.
February 17; Sausalito
Hemigrapsus nudus, 5.
Hemigrapsus oregonensis, 20.
March 4; Sausalito
Pagurus hirsutiusculus, 3.
Epialtus productus, 9.
Pachygrapsus crassipes, 1.
March 14; Sausalito
Hemigrapsus oregonensis, 6.
March 21; Sausalito
Pagurus hirsutiusculus, 2.
March 27; Angel Island, west of Blunt Point, 250-foot seine
Crago nigricauda, 22.
Crago stylirostris, 1.
Emerita analoga, 1.
April 3; Sausalito, electric light, ship's side
Crago franciscorum, 16.
April 19; Fort Baker, seine
Crago nigricauda, 16.
Crago nigromaculata, 11.
Crago franciscorum, 1.
Emerita analoga, 1.
Cancer magister, 1.

April 29; Tiburon, 150-foot seine
Crago nigricauda, many.
Crago franciscorum, 4.
Upogebia pugettensis, 2.
Cancer magister, 1.
Hemigrapsus oregonensis, 1.

May 13; Fort Baker beach, 250-foot seine
Crago nigricauda, 18.
Crago nigromaculata, 7.
Cancer magister, 7.

October 5; Sausalito
Cancer antennarius, 1.

October; Sausalito
Epialtus productus, 1.

APPENDIX II D

Miscellaneous Collections

"Fishing grounds," off Golden Gate, July, 1912.
Crago nigricauda, 7.
Crago stylirostris, 1.
Pagurus ochotensis, 3.
Paguristes bakeri, 7.
Oregonia gracilis, 1.
Cancer magister, 35.
Cancer gracilis, 2.

"Experimental trial of otter-trawl," off Golden Gate, April 6, 1914
Randallia ornata, 1.

"No label"
Holopagurus pilosus, 1.
Oedignathus inermis, 1.
Acantholithodes hispidus, 1.

IX. APPENDIX III

List of Correlated "Albatross" Dredging and Hydrographic Stations of the Years 1912 and 1913

For the purpose of rendering the hydrographic data obtained at hydrographic stations available for use in connection with the dredging stations, at which no such observations were made, this table correlating the two was drawn up at my suggestion by Mr. R. A. Coleman, clerk on the "Albatross."

Following the various dredging stations, the hydrographic stations most nearly related to them in point of time and position are given. These in turn are followed by the primary hydrographic station of the group to which each belongs (see Appendix II B, p. 340), together with their annual mean and the range of both temperature and salinity. These figures are, in a degree, applicable to the dredging stations with which they approximately correspond.

The actual observations for any particular hydrographic station may be ascertained by reference to Appendix II B (p. 342).

As to the method and procedure pursued in obtaining these data, the reader is referred to the *Report on the Physical Conditions in San Francisco Bay* (Sumner, 1914).

LIST OF CORRELATED "ALBATROSS" DREDGING AND HYDROGRAPHIC STATIONS OF THE YEARS 1912 AND 1913

Dredging station (for position see plates 2 and 3).		Nearest hydrographic station with respect to time and position (for position see corresponding primary station).				Primary hydrographic station (for position see plate 4).				
		Flood		Ebb			Temperature		Salinity	
No.	Date	No.	Date	No.	Date	No.	Mean	Range	Mean	Range
MIDDLE	1912		1912		1912		C.	C.	‰	‰
5700	Jan. 30	5000	Feb. 21	4967	Feb. 13	4967	12.01	8.7–14.3	31.04	26.6–33.3
5702	"	"	"	"	"	"	"	"	"	"
5705	Feb. 6	4997	Feb. 21	4970	Feb. 13	4970	12.69	8.5–17.1	28.52	19.7–32.8
5706	"	"	"	"	"	"	"	"	"	"
5707	Feb. 6	4993	Feb. 21	4974	Feb. 13	4974	13.05	7.8–18.0	24.39	15.2–30.1
5708	"	"	"	"	"	"	"	"	"	"
5709	"	"	"	"	"	"	"	"	"	"
5710	Feb. 16	5000	Feb. 21	4967	Feb. 13	4967	12.01	8.7–14.3	31.04	26.6–33.3
5711	"	"	"	"	"	"	"	"	"	"
5712	"	"	"	"	"	"	"	"	"	"
5713	"	"	"	"	"	"	"	"	"	"
5714	Feb. 28	4993	Feb. 21	4974	Feb. 13	4974	13.05	7.8–18.0	24.39	15.2–30.1
UPPER										
5715	Feb. 28	4992	Feb. 21	4981	Feb. 15	4981	13.29	7.1–17.3	25.33	13.8–32.5
5716	Feb. 28	4991	Feb. 20	4980	Feb. 15	4980	12.44	7.1–17.2	24.98	16.2–30.1
5717	"	"	"	"	"	"	"	"	"	"
MIDDLE										
5718	Feb. 28	4998	Feb. 21	4969	Feb. 1	4969	12.72	8.7–19.5	29.61	20.8–32.8
UPPER										
5719	Mar. 1	4990	Feb. 20	4979	Feb. 15	4979..	13.06	7.1–18.1	24.46	13.1–28.9
5720	Mar. 1	4986	Feb. 20	4975	Feb. 15	4975	13.14	6.0–19.3	15.24	3.3–21.2
5721	Mar. 1	4987	Feb. 20	4976	Feb. 15	4976	13.06	6.0–18.5	15.69	3.8–21.4
5722	Mar. 1	4988	Feb. 20	4977	Feb. 15	4977	13.29	6.2–19.6	17.35	4.2–23.3
LOWER										
5723	Mar. 6	5007	Feb. 23	5010	Feb. 27	5007	12.85	8.7–17.1	28.76	26.1–32.5
5724	Mar. 6	5006	Feb. 23	5012	Feb. 27	5006	13.17	8.2–17.4	28.50	25.6–31.7
5725	"	"	"	"	"	"	"	"	"	"
5726	Mar. 8	5005	Feb. 23	5013	Feb. 27	5005	13.28	8.1–18.2	28.47	24.9–31.4
5727	"	"	"	"	"	"	"	"	"	"
5729	Mar. 8	5003	Feb. 23	5015	Feb. 27	5003	13.81	7.7–18.8	28.68	27.0–31.6
5730	Mar. 8	5002	Feb. 23	5016	Feb. 27	5002	13.75	7.6–19.3	28.90	26.9–31.3

List of Correlated "Albatross" Dredging and Hydrographic Stations of the Years 1912 and 1913—(*Continued*)

Dredging station (for position see plates 2 and 3).		Nearest hydrographic station with respect to time and position (for position see corresponding primary station).				Primary hydrographic station (for position see plate 4).				
		Flood		Ebb			Temperature		Salinity	
No.	Date	No.	Date	No.	Date	No.	Mean	Range	Mean	Range
Outside	1912		1912		1912		C.	C.	‰	‰
5731	Mar. 11	No hydrographic stations near enough with respect to time. The outside hydrographic stations are H 5219–5227, inclusive, see dredging stations D 5785–5792, 5806, and 5807 in this table.				Outside				
5732	"					"				
5733	"					"				
5734	"					"				
5735	"					"				
5736	"					"				
5737	"					"				
Middle										
5738	Mar. 13	5000	Feb. 21	4967	Feb. 13	4967	12.01	8.7–14.3	31.04	26.6–33.3
5739	Mar. 13	4999	Feb. 21	4968	Feb. 13	4968	12.26	8.7–16.0	30.07	23.0–33.2
5740	"	"	"	"	"	"	"	"	"	"
5741	Mar. 18	4997	Feb. 21	4970	Feb. 13	4970	12.69	8.5–17.1	28.52	19.7–32.8
5742	"	"	"	"	"	"	"	"	"	"
5743	Mar. 18	4999	Feb. 21	4968	Feb. 13	4968	12.26	8.7–16.0	30.07	23.0–33.2
5744	"	"	"	"	"	"	"	"	"	"
5745	Mar. 18	5008	Feb. 23	5009	Feb. 27	5008	12.64	8.5–17.0	29.14	25.9–32.7
5746	Mar. 18	5000	Feb. 21	4967	Feb. 13	4967	12.01	8.7–14.3	31.04	26.6–33.3
5747	Mar. 19	4995	Feb. 21	4972	Feb. 13	4972	12.88	8.2–18.2	26.96	18.0–32.3
5748	Mar. 19	4994	Feb. 21	4973	Feb. 13	4973	12.99	7.9–17.8	25.49	14.9–30.4
5749	"	"	"	"	"	"	"	"	"	"
5750	Mar. 20	4993	Feb. 21	4974	Feb. 13	4974	13.05	7.8–18.0	24.39	15.2–30.1
5751	"	"	"	"	"	"	"	"	"	"
Upper										
5752	Mar. 20	5105	April 30	5082	April 23	4981	13.29	7.1–17.3	25.33	13.8–32.5
Middle										
5753	Mar. 20	4993	Feb. 21	4974	Feb. 13	4974	13.05	7.8–18.0	24.39	15.2–30.1
5754	Mar. 25	4998	Feb. 21	4969	Feb. 13	4969	12.72	8.7–19.5	29.61	20.8–32.8
5755	Mar. 25	5008	Feb. 23	5009	Feb. 27	5008	12.64	8.5–17.0	29.14	25.9–32.7
5756	Mar. 26	4995	Feb. 21	5102	April 29	4972	12.88	8.2–18.2	26.96	18.0–32.3
Upper										
5757	Mar. 26	5105	April 30	5082	April 23	4981	13.29	7.1–17.3	25.33	13.8–32.5
5758	"	"	"	"	"	"	"	"	"	"
5759	April 1	5087	April 23			4976	13.06	6.0–18.5	15.69	3.8–21.4
5760	April 2	5088	April 23			4975	13.14	6.0–19.3	15.24	3.3–21.2
5761	"	"	"			"	"	"	"	"

LIST OF CORRELATED "ALBATROSS" DREDGING AND HYDROGRAPHIC STATIONS OF THE YEARS 1912 AND 1913—(*Continued*)

Dredging station (for position see plates 2 and 3).		Nearest hydrographic station with respect to time and position (for position see corresponding primary station).				Primary hydrographic station (for position see plate 4).				
		Flood		Ebb			Temperature		Salinity	
No.	Date	No.	Date	No.	Date	No.	Mean	Range	Mean	Range
MIDDLE	1912		1912		1912		C.	C.	‰	‰
5762	April 3	5120	May 6	5097	April 29	4967	12.01	8.7–14.3	31.04	26.6–33.3
5763	"	"	"	"	"	"	"	"	"	"
5764	April 3	5122	May 6	5099	April 29	4969	12.72	8.7–19.5	29.61	20.8–32.8
5765	April 3	5121	May 6	5098	April 29	4968	12.26	8.7–16.0	30.07	23.0–33.2
LOWER										
5766	April 8	5112	May 1	5089	April 26	5008	12.64	8.5–17.0	29.14	25.9–32.7
5767	April 9	5113	May 1	5090	April 26	5007	12.85	8.7–17.1	28.76	26.1–32.5
5768	"	"	"	"	"	"	"	"	"	"
MIDDLE										
5769	April 15	5120	May 6	5097	April 29	4967	12.01	8.7–14.3	31.04	26.6–33.3
5770	"	"	"	"	"	"	"	"	"	"
5771	"	"	"	"	"	"	"	"	"	"
5772	"	"	"	"	"	"	"	"	"	"
5773	"	"	"	"	"	"	"	"	"	"
5774	April 16	"	"	"	"	"	"	"	"	"
5775	"	"	"	"	"	"	"	"	"	"
5776	April 17	"	"	"	"	"	"	"	"	"
5777	"	"	"	"	"	"	"	"	"	"
5778	"	"	"	"	"	"	"	"	"	"
5779	May 8	"	"	"	"	"	"	"	"	"
UPPER										
5780	May 13	5107	April 30	5084	April 23	4979	13.06	7.1–18.1	24.46	13.1–28.9
LOWER										
5781	May 27	5119	May 1	5096	April 26	5001	13.69	7.6–19.4	28.80	26.8–31.5
5782	"	"	"	"	"	"	"	"	"	"
5783	May 28	"	"	"	"	"	"	"	"	"
5784	"	"	"	"	"	"	"	"	"	"
OUTSIDE										
5785	Oct. 15	5220	Oct. 15	5219	Oct. 15	Outside	11.06	9.8–12.1	34.04	33.8–34.2
5786	"	"	"	"	"	"	11.67	11.0–12.2	34.08	34.1–34.1
5787	"	"	"	"	"	"	11.67	11.0–12.3	34.08	34.1–34.1
5788	Oct. 21	"	"	5221	Oct. 21	"	10.17	9.3–11.3	34.05	34.0–34.2
5789	"	"	"	5222	"	"	10.72	9.4–11.4	34.10	33.8–34.3
5790	Oct. 22	"	"	5223	Oct. 22	"	10.61	9.7–11.5	33.90	33.9–33.9
5791	"	"	"	5224	"	"	10.22	9.6–11.3	34.05	33.9–34.3
5792	"	"	"	5225	"	"	11.06	11.0–11.1	34.05	34.0–34.1

List of Correlated "Albatross" Dredging and Hydrographic Stations of the Years 1912 and 1913—(*Continued*)

Dredging station (for position see plates 2 and 3).		Nearest hydrographic station with respect to time and position (for position see corresponding primary station).				Primary hydrographic station (for position see plate 4).				
		Flood		Ebb			Temperature		Salinity	
No.	Date	No.	Date	No.	Date	No.	Mean	Range	Mean	Range
Upper	1912		1912		1912		C.	C. .	‰	‰
5793	Oct. 28	5196	Oct. 10	5179	Oct. 7	4975	13.14	6.0–19.3	15.24	3.3–21.2
5794	"	"	"	"	"	"	"	"	"	"
Middle										
5795	Oct. 29	5215	Oct. 12	5191	Oct. 9	4970	12.69	8.5–17.1	28.52	19.7–32.8
5796	"	"	"	"	"	"	"	"	"	"
5797	"	"	"	"	"	"	"	"	"	"
5798	Oct. 29	5214	Oct. 12	5192	Oct. 9	4971	12.71	8.3–18.1	28.13	18.3–32.7
5799	"	"	"	"	"	"	"	"	"	"
5800	Oct. 29	5218	Oct. 12	5188	Oct. 9	4967	12.01	8.7–14.3	31.04	26.6–33.3
5801	"	"	"	"	"	"	"	"	"	"
Lower										
5802	Oct. 30	5204	Oct. 11	5181	Oct. 8	5007	12.85	8.7–17.1	28.76	26.1–32.5
5803	Oct. 30	5205	Oct. 11	5182	Oct. 8	5006	13.17	8.2–17.4	28.50	25.6–31.7
5804	Oct. 30	5206	Oct. 11	5183	Oct. 8	5005	13.28	8.1–18.2	28.47	24.9–31.4
5805	Oct. 30	5207	Oct. 11	5184	Oct. 8	5004	13.53	7.7–18.6	28.67	27.0–31.3
Outside										
5806	Nov. 4	.....	.....	5226	Nov. 4	Outside	11.61	11.1–12.2	33.49	33.1–34.0
5807	"	.....	.....	5227	"	"	12.06	11.9–12.3	32.87	32.8–32.9
Middle										
5808	Nov. 4	5240	Nov. 25	5277	Dec. 5	4967	12.01	8.7–14.3	31.04	26.6–33.3
5809	"	"	"	"	"	"	"	"	"	"
Lower										
5810	Nov. 11	5248	Nov. 27	5229	Nov. 11	5001	13.69	7.6–19.4	28.80	26.8–31.5
5811	"	"	"	5231	"	"	"	"	"	"
5812	Nov. 27	"	"	5260	Nov. 22	"	"	"	"	"
5813	"	5256	"	"	"	"	"	"	"	"
5814	"	5258	"	"	"	"	"	"	"	"
Upper										
5815	Dec. 9	5241	Nov. 26	5268	Dec. 3	4975	13.14	6.0–19.3	15.24	3.3–21.2
5816	Dec. 9	5242	Nov. 26	5267	Dec. 3	4976	13.06	6.0–18.5	15.69	3.8–21.4
5817	Dec. 9	5243	Nov. 26	5266	Dec. 3	4977	13.29	6.2–19.6	17.35	4.2–23.3
5818	Dec. 10	5244	Nov. 26	5265	Dec. 3	4978	12.68	6.5–18.3	19.62	8.1–27.0
5819	Dec. 10	5246	Nov. 26	5263	Dec. 3	4980	12.44	7.1–17.2	24.98	16.2–30.1
5820	Dec. 10	.....	.....	5262	Dec. 3	4981	13.29	7.1–17.3	25.33	13.8–32.5

LIST OF CORRELATED "ALBATROSS" DREDGING AND HYDROGRAPHIC STATIONS OF THE YEARS 1912 AND 1913—(*Concluded*)

Dredging station (for position see plates 2 and 3).		Nearest hydrographic station with respect to time and position (for position see corresponding primary station).				Primary hydrographic station (for position see plate 4).				
		Flood		Ebb			Temperature		Salinity	
No.	Date	No.	Date	No.	Date	No.	Mean	Range	Mean	Range
MIDDLE	1912		1912		1912		C.	C.	‰	‰
5821	Dec. 17	5235	Nov. 25	5282	Dec. 5	4972	12.88	8.2–18.2	26.96	18.0–32.3
5822	Dec. 17	5233	Nov. 25	5284	Dec. 5	4974	13.05	7.8–18.0	24.39	15.2–30.1
5823	Dec. 17	5234	Nov. 25	5283	Dec. 5	4973	12.99	7.9–17.8	25.49	14.9–30.4
5824	Dec. 18	5233	Nov. 25	5284	Dec. 5	4974	13.05	7.8–18.0	24.39	15.2–30.1
5825	Dec. 18	5237	Nov. 25	5280	Dec. 5	4970	12.69	8.5–17.1	28.52	19.7–32.8
5826	Dec. 18 1913	5235	Nov. 25 1913	5282	Dec. 5 1913	4972	12.88	8.2–18.2	26.96	18.0–32.3
5827	Jan. 20	5328	Jan. 28	5297	Jan. 20	4967	12.01	8.7–14.3	31.04	26.6–33.3
5828	Jan. 20	5326	Jan. 28	5299	Jan. 20	4969	12.72	8.7–19.5	29.61	20.8–32.8
5829	Jan. 20	5328	Jan. 28	5297	Jan. 20	4967	12.01	8.7–14.3	31.04	26.6–33.3
5830	Jan. 21	5327	Jan. 28	5298	Jan. 20	4968	12.26	8.7–16.0	30.07	23.0–33.2
LOWER										
5833	Jan. 27	5320	Jan. 27	5305	Jan. 21	5008	12.64	8.5–17.0	29.14	25.9–32.7
5835	Feb. 3	5317	Jan. 27	5308	Jan. 21	5005	13.28	8.1–18.2	28.47	24.9–31.4
MIDDLE										
5845	April 7	No hydrographic station near enough with respect to time.				4967	12.01	8.7–14.3	31.04	26.6–33.3
LOWER										
5847	April 22	"	"	"	"	5001	13.69	7.6–19.4	28.80	26.8–31.5
5848	"	"	"	"	"	"	"	"	"	"
5849	"	"	"	"	"	"	"	"	"	"

X. EXPLANATION OF PLATES

All specimens figured are contained in the collections of the United States National Museum, except *Pinnixa barnharti,* male (pl. 41, figs. 1 and 4), which is in the Museum of Comparative Zoology at Cambridge, Massachusetts. Only where suitable California material of a particular species was unobtainable has that from other localities been utilized for photographing. Unless otherwise stated all localities are Californian, and before the numbers designating the "Albatross" stations D, signifying dredging, is to be understood.

Page references to the text are given below under the names of the species figured on the plates.

PLATE 1

COAST OF CALIFORNIA

A. Northern boundary of the state of California to San Francisco.

B. San Francisco to Point Conception.

C. Point Conception to southern boundary of the state of California.

The 100-fathom line is represented by the dotted line (.....); the 30-fathom line by dots and dashes (...—...—).

Each degree of latitude equals 60 nautical miles (one nautical mile equals 6086.7 feet, or 1.15 statute miles).

These outline maps are based on the U. S. Coast and Geodetic Survey's Chart No. 5200.

PLATE 2

Dredging stations of the "Albatross" in San Francisco Bay during 1912 and 1913 (from Sumner, *et al.*, Univ. Calif. Publ. Zool., 1914, pl. 1).

Addenda et Corrigenda

Complete parenthesis after station 5814 (A), in insert carrying extreme lower end of bay.

Station 5732 east of Pt. San Mateo should be 5782.

The Standard Oil pier is the pier paralleling the number designating station 5756.

Red Rock is the island below station 5753 and west of the number designating it.

Bluff Point is the large point of land at the extreme northern end of Raccoon Strait near the number designating station 5795.

Mission Rock is the island off the San Francisco shore west of stations 5723 and 5802.

Potrero Point (San Francisco side of bay) is the most prominent one on the line of 37° 45′ N.

Potrero Point (east side of bay near extreme lower end) is the prominent point of land north of the number designating station 5812 (A).

PLATE 3

Dredging stations of the "Albatross" outside of San Francisco Bay during 1912 (from Sumner, *et al.*, 1914, pl. 2).

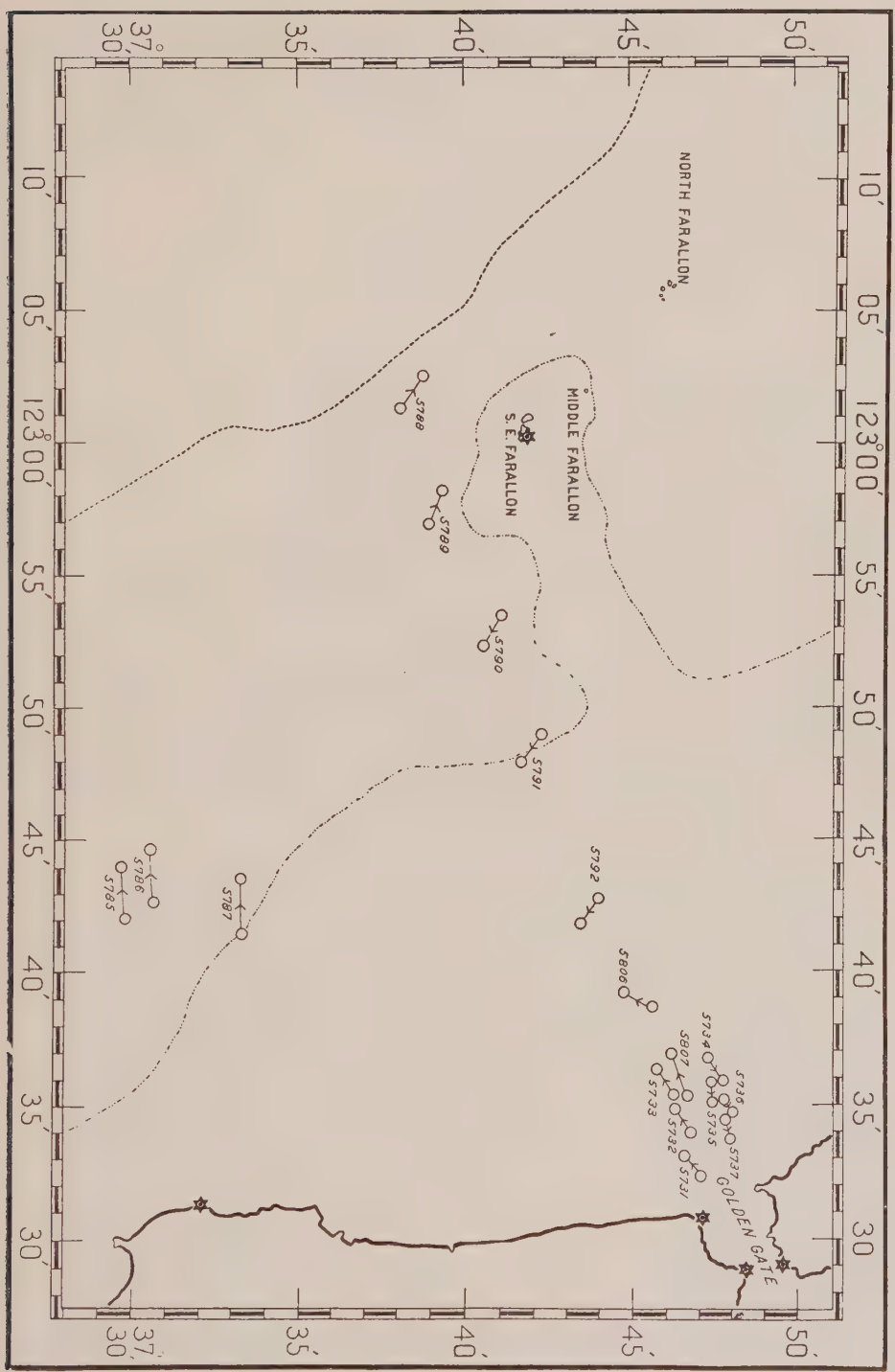
NORTH FARALLON
MIDDLE FARALLON
S. E. FARALLON
GOLDEN GATE
5788
5789
5790
5791
5792
5606
5807
5733
5732
5731
5734
5735
5736
5737
5786
5785
5787
37° 30'
35'
40'
45'
50'
10'
05'
123° 00'
55'
50'
45'
40'
35'
30'

PLATE 4

Primary hydrographic stations of the "Albatross" in San Francisco Bay during 1912 and 1913 (from Sumner, *et al*, 1914, pl. 3). The figures in bold face type accompanying each of the primary stations give the mean annual water temperature at that station in degrees Centigrade.

In order to ascertain the position of other than "primary" stations consult Appendix II B (p. 342).

SAN PABLO BAY
VALLEJO
SUISUN BAY
CARQUINEZ STRAIT
MARTINEZ
Pt San Pedro
Pinole Pt.
Pt San Quentin
Pt San Pablo
Pt Richmond
RACCOON STRAIT
SAUSALITO
Pt Bonita
GOLDEN GATE
Pt Lobos
SAN FRANCISCO
Hunters Pt
BERKELEY
PIER
KEY ROUTE PIER
OAKLAND
S.P PIER
FERRY BUILDING
ALAMEDA
PALO ALTO
SAN FRANCISCO BAY
CALIFORNIA
NAUTICAL MILES
KILOMETERS
Pt San Pedro
Pt San Mateo
4976
4977 13.29
4975 13.06
13.14
4978 12.68
4979 13.06
4980 12.44
4981 13.29
4974 13.05
4973 12.99
4972 12.88
4971 12.71
4970 12.69
4969 12.72
4968 12.26
4967 12.01
5008 12.64
5007 12.85
5006 13.17
5005 13.28
5004 13.53
5003 13.81
5002 13.75
5001 13.69

PLATE 5

Distribution of *Pandalus danae* (p. 45) ○ and *Cancer productus* (p. 222) ● in San Francisco Bay.

122°30'
25'
20'
15'
10'
05'
NAPA CREEK
VALLEJO
SUISUN BAY
SAN PABLO BAY
CARQUINEZ STRAIT
MARTINEZ
Pinole Pt
Pt San Pedro
Pt San Quentin
Pt San Pablo
Pt Richmond
RACCOON STRAIT
SAUSALITO
ANGEL I.
PIER
BERKELEY
KEY ROUTE PIER
OAKLAND
S.P. PIER
PALO ALTO
Pt Bonita
GOLDEN GATE
FERRY BUILDING
Pt Lobos
SAN FRANCISCO
ALAMEDA
Hunters Pt
SAN FRANCISCO BAY
CALIFORNIA
NAUTICAL MILES
KILOMETERS
Pt San Pedro
Pt San Mateo
FRED W. S. BLANCHARD DEL.

PLATE 6

Distribution of *Spirontocaris cristata* (p. 70) ● and *Cancer gracilis* (p. 232) ○ in San Francisco Bay. (Dotted symbols represent hydrographic stations.)

122°30′
25′
20′
15′
10′
05′
NAPA CREEK
VALLEJO
SUISUN BAY
SAN PABLO BAY
CARQUINEZ STRAIT
MARTINEZ
VARN 16.5 E IN 1914 ANNUAL INCREASE 3′
Pt San Pedro
Pindle Pt
Pt San Quentin
San Pablo
Pt Richmond
RACCOON STRAIT
SAUSALITO
ANGEL I.
PIER
BERKELEY
Pt Bonita
KEY ROUTE PIER
OAKLAND
S.P.PIER
PALO ALTO
GOLDEN GATE
FERRY BUILDING
Pt Lobos
SAN FRANCISCO
ALAMEDA
Hunters Pt
SAN FRANCISCO BAY
CALIFORNIA
NAUTICAL MILES
KILOMETERS
Pt San Pedro
Pt San Mateo
FRED W. S. BLANCHARD DEL.

PLATE 7

Distribution of *Crago stylirostris* (p. 91) ● and *C. nigromaculata* (p. 87) ○ in San Francisco Bay. (Dotted symbols represent hydrographic stations. Of these the one in the lower bay represents two stations having approximately the same position.)

122° 30′
25′
20′
15′
10′
05′
NAPA CREEK
VALLEJO
SUISUN BAY
SAN PABLO BAY
CARQUINEZ STRAIT
MARTINEZ
Pinole Pt
Pt San Pedro
Pt San Quentin
San Pablo
Pt Richmond
RACCOON STRAIT
ANGEL I.
SAUSALITO
Pt Bonita
GOLDEN GATE
PIER
BERKELEY
KEY ROUTE PIER
OAKLAND
S.P. PIER
PALO ALTO
FERRY BUILDING
Pt Lobos
SAN FRANCISCO
ALAMEDA
Hunters Pt
SAN FRANCISCO BAY
CALIFORNIA
NAUTICAL MILES
KILOMETERS
Pt San Pedro
Pt San Mateo
FRED W. S. BLANCHARD DEL.

PLATE 8

Distribution of *Callianassa longimana* (p. 118) ● and *Pagurus hirsutiusculus* (p. 138) ○ in San Francisco Bay. (Dotted symbol represents in this case two hydrographic stations having approximately the same position.)

122°30′
25′
20′
15′
10′
05′
NAPA CREEK
VALLEJO
SUISUN BAY
SAN PABLO BAY
CARQUINEZ STRAIT
MARTINEZ
Pinole Pt
Pt San Pedro
Pt San Quentin
Pt San Pablo
Pt Richmond
RACCOON STRAIT
SAUSALITO
Pt Bonita
GOLDEN GATE
PIER
BERKELEY
KEY ROUTE PIER
OAKLAND
S.P.PIER
PALO ALTO
ALAMEDA
FERRY BUILDING
Pt Lobos
SAN FRANCISCO
Hunters Pt
SAN FRANCISCO BAY
CALIFORNIA
NAUTICAL MILES
KILOMETERS
Pt San Pedro
Pt San Mateo
FRED'K W. S. BLANCHARD DEL.

PLATE 9

Distribution of *Pinnixa franciscana* (p. 263) ● and *P. schmitti* (p. 264) ○ in San Francisco Bay.

122°30′
25′
20′
15′
10′
05′
37° 35′
38° 00′
38° 05′
40′
45′
50′
55′
NAPA CREEK
VALLEJO
SUISUN BAY
SAN PABLO BAY
CARQUINEZ STRAIT
MARTINEZ
Pinole Pt
Pt San Pedro
Pt San Quentin
San Pablo
Pt Richmond
RACCOON STRAIT
SAUSALITO
ANGEL I.
Pt Bonita
GOLDEN GATE
FERRY BUILDING
Pt Lobos
SAN FRANCISCO
Hunters Pt
Pt San Pedro
Pt San Mateo
PIER
BERKELEY
KEY ROUTE PIER
OAKLAND
S.P. PIER
PALO ALTO
ALAMEDA
SAN FRANCISCO BAY
CALIFORNIA
NAUTICAL MILES
KILOMETERS
FRED W. S. BLANCHARD DEL.

PLATE 10

Distribution of *Cancer magister* (p. 229) ● and *Hemigrapsus oregonensis* (p. 274) ○ in San Francisco Bay. (Dotted symbols represent hydrographic stations.)

122°30'
25'
20'
15'
10'
05'
NAPA CREEK
VALLEJO
SUISUN BAY
SAN PABLO BAY
CARQUINEZ STRAIT
MARTINEZ
VARN
1915 E IN 1914
ANNUAL INCREASE
3'
180
Pt San Pedro
Pinole Pt
Pt San Quentin
San Pablo
Pt Richmond
RACCOON STRAIT
SAUSALITO
PIER
BERKELEY
Pt Bonita
KEY ROUTE PIER
OAKLAND
S.P.PIER
PALO ALTO
GOLDEN GATE
FERRY BUILDING
Pt Lobos
SAN FRANCISCO
ALAMEDA
Hunters Pt
SAN FRANCISCO BAY
CALIFORNIA
NAUTICAL MILES
KILOMETERS
Pt San Pedro
Pt San Mateo
FRED W. S. BLANCHARD DEL.

PLATE 11

Fig. 1. *Gennadas pectinatus,* female holotype; lateral view, × about 1$\frac{1}{10}$. Off San Nicolas Island, 2182–1350 fathoms. (''Albatross'' station 4390.) (Page 25.)

Fig. 2. *Benthesicymus altus,* female; lateral view, × about 1$\frac{1}{10}$. Off San Nicolas Island, 2182–1350 fathoms. (''Albatross'' station 4390.) (Page 22.)

1

2

PLATE 12

Fig. 1. *Synalpheus lockingtoni,* female; dorsal view, × 1⅕. Beach at Venice, in roots of *Neriocystis.* (Page 77.)

Fig. 2. *Betaeus longidactylus,* female; lateral view, × 1⅕. Rocky Point, San Pedro. (Page 80.)

Fig. 3. *Crago lomae,* male holotype; lateral view, × 1⅕. Off Point Loma, 525–541–514 fathoms. ("Albatross" station 4334.) (Page 100.)

Fig. 4. *Crago lomae,* female paratype; dorsal view, × 1⅕. Off Point Loma, 639–628–640 fathoms. ("Albatross" station 4353.) (Page 100.)

Fig. 5. *Palaemonetes hiltoni,* female holotype; lateral view, × 2⅗. San Pedro. (Page 36.)

Fig. 6. *Processa canaliculata,* male; lateral view, × 1⅕. Off San Joseph Island, Gulf of California, 40 fathoms. ("Albatross" station 2998.) (Page 81.)

Fig. 7. *Sergestes similis,* female; lateral view, × 1⅕. Santa Barbara Channel, 322 fathoms. ("Albatross" station 2903.) (Page 19.)

Fig. 8. *Spirontocaris franciscana,* female holotype; dorsal view, × 1⅕. San Francisco Bay, 5–7½ fathoms. ("Albatross" station 5770.) (Page 60.)

Fig. 9. Same specimen as fig. 8; lateral view.

Fig. 10. *Spirontocaris lagunae,* female; dorsal view, × 2. Laguna Beach. (Page 57.)

Fig. 11. Same specimen as fig. 10; lateral view.

1
2
3
4
5
6
7
8
9
10
11

PLATE 13

Fig. 1. *Pandalus gurneyi,* female; lateral view, × 1⅔. Off Santa Barbara, 21 fathoms. (''Albatross'' station 2961.) (Page 46.)

Fig. 2. *Pandalus montagui tridens,* female holotype; lateral view, × 1$\frac{3}{10}$. Off North Head, Akutan Island, Alaska, 72 fathoms. (''Albatross'' station 2842.) (Page 42.)

Fig. 3. *Pandalus danae,* male; lateral view, × 1⅜. San Francisco Bay, 10¼–16½ fathoms. (''Albatross'' station 5828.) (Page 44.)

PLATE 14

Fig. 1. *Pandalus jordani,* male; lateral view, × 2$\frac{1}{10}$. Off San Francisco, 40 fathoms. (''Albatross'' station 5786.) (Page 41.)

Fig. 2. *Pandalopsis ampla,* male; lateral view, × 1$\frac{1}{10}$. Near Cortez Bank, 776 fathoms. (''Albatross'' station 3627.) (Page 46.)

Fig. 3. *Pandalus platyceros,* male; lateral view, × $\frac{9}{10}$. Off Farallon Islands, 191 fathoms. (''Albatross'' station 3161.) (Page 43.)

1

2

3

PLATE 15

Eryonicus agassizi, female, × about 1¼. Off San Clemente Island, 654–704 fathoms. ("Albatross" station 4405.) (Page 105.)

Fig. 1. Lateral view.

Fig. 2. Dorsal view.

1
2

PLATE 16

Fig. 1*a*. *Pylopagurus minimus,* male; dorsal view, × 4$\frac{1}{10}$. Off Farallon Islands, 33–35 fathoms. (''Albatross'' station 5790.) (Page 144.)

Fig. 1*b*. Same specimen as 1*a*; large hand, × 4$\frac{1}{10}$.

Fig. 1*c*. Shell of *Dentalium indianorum* Carpenter, encrusted with much worn, indeterminate bryozoa, from which above *P. minimus* was taken, × 4$\frac{1}{10}$.

Fig. 2. *Pagurus samuelis,* series of hands, ×1½. All from males except fifth and last, the smallest. Pacific Grove. (Page 139.)

Fig. 3. *Pagurus samuelis,* female; dorsal view, ×1½. Pacific Grove. (Page 139.)

Fig. 4. *Pagurus hirsutiusculus,* male; dorsal view, ×1½. Bonita Point, between tide marks. (Page 137.)

Fig. 5. *Parapagurus mertensii,* male; dorsal view, ×1½. Off Santa Cruz Island, 266 fathoms. (''Albatross'' station 2948.) (Page 146.)

PLATE 17

Fig. 1. *Paguristes parvus,* female cotype; dorsal view, ×3⅖. White's Point, near San Pedro. (Page 124.)

Fig. 2. *Holopagurus pilosus;* dorsal view, natural size. (Page 127.)

Fig. 3. *Dardanus jordani,* male holotype; dorsal view, ×1⅓. San Francisco Bay. (Page 126.)

Fig. 4. Same specimen as fig. 3; anterodorsal view, to show large hand.

PLATE 18

Fig. 1. *Paguristes turgidus,* male; dorsal view, × 95/100. Off San Francisco, 13–14¼ fathoms. ("Albatross" station 5806.) (Page 123.)

Fig. 2. *Paguristes bakeri,* male; dorsal view, × 74/100. Off Santa Barbara, 29 fathoms. ("Albatross" station 2971.) (Page 124.)

Fig. 3. *Paguristes ulreyi,* male; dorsal view, × 94/100. Santa Monica Bay. (Page 125.)

Fig. 4. *Paguristes ulreyi,* female paratype; dorsal view, without abdomen, × 1¼. Off San Diego, 25 fathoms. ("Albatross" station 4304.) (Page 125.)

Fig. 5. Same species as fig. 4; male holotype.

Fig. 6. *Paguristes bakeri,* young female; dorsal view of anterior portion of carapace to show comparative length of eyestalks, × 4 2/5. Portuguese Bend, near San Pedro. (Page 124.)

Fig. 7. *Paguristes ulreyi,* young female; dorsal view of anterior portion of carapace to show comparative length of eyestalks, × 4. La Jolla. (Page 125.)

Fig. 8. *Paguristes turgidus,* young female; dorsal view of anterior portion of carapace to show comparative length of eyestalks, × 4 1/10. Off Farallon Islands, 68 fathoms. ("Albatross" station 3672.) (Page 123.)

PLATE 19

Fig. 1. *Oedignathus inermis,* male; dorsal view, × 1⅖. San Francisco? (Page 151.)

Fig. 2. *Acantholithodes hispidus,* female; dorsal view, natural size. Off San Francisco? (Page 152.)

PLATE 20

Fig. 1. *Cryptolithodes typicus*, male; ventral view, × 1½. Unalaska, Alaska. (Page 154.)

Fig. 2. Same specimen as fig. 1; dorsal view.

Fig. 3. *Cryptolithodes sitchensis*, male; ventral view, × 1½. Tunitas Glen. (Page 155.)

Fig. 4. Same specimen as fig. 3; dorsal view.

PLATE 21

Fig. 1. *Lopholithodes mandtii,* male; dorsal view, about natural size. Monterey Bay. (Page 156.)

Fig. 2. *Lopholithodes foraminatus;* dorsal view, about natural size. Monterey Bay, 69 fathoms. (''Albatross'' station 3125.) (Page 157.)

PLATE 22

Fig. 1. *Rhinolithodes wosnessenskii*, male; dorsal view, × 1 1/10. Portlock Bank, Alaska, ,68 fathoms. (''Albatross'' station 2856.) (Page 158.)

Fig. 2. *Phyllolithodes papillosus*, male; dorsal view, × nearly 1¼. California. (Page 153.)

PLATE 23

Paralomis multispina, male; dorsal view, × 64/100. Off Cape St. James, British Columbia, 876 fathoms. ("Albatross" station 2860.) (Page 159.)

PLATE 24

Paralomis verrilli, female holotype; dorsal view, × 81/100. Bering Sea, off Pribilof Islands, 688 fathoms. ("Albatross" station 3501.) (Page 159.)

PLATE 25

Paralithodes californiensis, female holotype; dorsal view, × 7%100. Off Santa Cruz Islands, 155 fathoms. ("Albatross" station 2949.) (Page 161.)

PLATE 26

Paralithodes rathbuni, male holotype; dorsal view, × 77/100. Off San Simeon Bay, 211 fathoms. ("Albatross" station 3191.) (Page 160.)

PLATE 27

Paralithodes rathbuni, female; dorsal view, × 7¼/100. Off Point Loma, 201–215 fathoms. ("Albatross" station 4367.) (Page 160.)

PLATE 28

Lithodes couesi, male; dorsal view, × $^{58}/_{100}$. Off San Clemente Island, 500 fathoms. ("Albatross" station 4400.) (Page 162.)

PLATE 29

Fig. 1. *Hapalogaster cavicauda,* female; dorsal view, × 1$^{3}/_{10}$. Monterey Bay. (Page 150.)

Fig. 2. *Hapalogaster grebnitzkii,* male; dorsal view, with pubescence mostly removed, × 1$^{3}/_{10}$. Sand Point, Humboldt Bay. (Page 150.)

Fig. 3. *Lithodes couesi,* young; dorsal view, × 1$^{3}/_{5}$. Off Point Loma, 500–530–524 fathoms. ("Albatross" station 4335.) (Page 162.)

Fig. 4. *Lithodes couesi,* male; posterior view to show basal (second) abdominal segment, × $^{86}/_{100}$. (See plate 28.) (Page 162.)

Fig. 5. Same specimen as fig. 4; ventral view of abdomen.

Fig. 6. *Paralithodes rathbuni,* female; posterior view to show basal (second) abdominal segment, × $^{86}/_{100}$. (See plate 27.) (Page 160.)

Fig. 7. Same specimen as fig. 6; ventral view of abdomen.

PLATE 30

Fig. 1. *Paralithodes californiensis,* female holotype; posterior view to show basal (second) abdominal segment, $^{76}/_{100}$. (See plate 25.) (Page 161.)

Fig. 2. Same specimen as fig. 1; ventral view of abdomen.

Fig. 3. *Paralithodes rathbuni,* male holotype; posterior view to show basal (second) abdominal segment, × $^{76}/_{100}$. (See plate 26.) (Page 160.)

Fig. 4. Same specimen as fig. 3; ventral view of abdomen.

Fig. 5. *Paralomis verrilli,* female holotype; posterior view to show basal (second) abdominal segment, × $^{76}/_{100}$. (See plate 24.) (Page 159.)

Fig. 6. Same specimen as fig. 5; ventral view of abdomen.

Fig. 7. *Paralomis multispina,* male; posterior view to show basal (second) abdominal segment, × $^{76}/_{100}$. (See plate 23.) (Page 159.)

Fig. 8. Same specimen as fig. 7; ventral view of abdomen.

PLATE 31

Fig. 1. *Munidopsis aspera,* male; dorsal view, × 1⅕. Off Point Loma. 471–510 fathoms. (''Albatross'' station 4317.) (Page 171.)

Fig. 2. *Pleuroncodes planipes,* female; dorsal view, × 1⅕. Magdalena Bay, Lower California. (Page 163.)

Fig. 3. *Munida hispida,* male; dorsal view, × 1⅕. Off Santa Catalina Island, 178–195 fathoms. (''Albatross'' station 4410.) (Page 166.)

Fig. 4. *Lepidopa myops,* female; dorsal view, × 1¼. Long Beach. (Page 172.)

Fig. 5. *Emerita analoga,* female; dorsal view, × 1$^{3}/_{10}$. Willow Camp, Marin County. (Page 173.)

Fig. 6. *Blepharipoda occidentalis,* male; dorsal view, × $^{9}/_{10}$. Long Beach. (Page 172.)

Fig. 7. *Homola faxoni,* male; dorsal view, × ⅔. Off Point Loma, 67–73 fathoms. (''Albatross'' station 4309.) (Page 184.)

PLATE 32

Fig. 1. *Petrolisthes cinctipes,* male; dorsal view, × 1⅓. Pacific Grove. (Page 179.)

Fig. 2. *Petrolisthes eriomerus,* male; dorsal view, × 1⅖. Seattle, Washington. (Page 180.)

Fig. 3. *Petrolisthes rathbunae,* female holotype; dorsal view, × 1 1/10. San Clemente Island. (Page 181.)

Fig. 4. *Petrolisthes gracilis,* male; dorsal view, × 1⅖. Monterey Bay. (Page 181.)

PLATE 33

Fig. 1. *Dromidia larraburei,* female; dorsal view, × 83/100. Long Beach. (Page 183.)

Fig. 2. *Pachycheles rudis,* male; dorsal view, × 13/10. Pacific Grove. (Page 176.)

Fig. 3. *Pachycheles holosericus,* female holotype; dorsal view, × 94/100. Santa Monica, or San Pedro Bay. (Page 177.)

Fig. 4. *Pachycheles pubescens,* female; dorsal view, × 17/10. Port Orchard, Washington. (Page 177.)

Fig. 5. *Pugettia dalli,* male; dorsal view, × about 2. Isthmus Harbor, Santa Catalina Island. (Page 208.)

Fig. 6. *Pugettia richii,* male; dorsal view, × 1½. Venice. (Page 207.)

Fig. 7. *Pugettia gracilis,* male; dorsal view, × 91/100. Straits of Fuca. (Page 206.)

PLATE 34

Fig. 1. *Pelia clausa,* male; dorsal view, × about 2. Venice. (Page 211.)

Fig. 2. Same specimen as fig. 1; ventral view.

Fig. 3. *Pelia clausa,* female; dorsal view, × about 2. Venice. (Page 211.)

Fig. 4. Same specimen as fig. 3; ventral view.

Fig. 5. *Pelia tumida,* male; dorsal view, right horn of rostrum broken, × about 2. Laguna Beach. (Page 211.)

Fig. 6. Same specimen as fig. 5; ventral view.

Fig. 7. *Speocarcinus californiensis,* male; dorsal view, × about 1½. West Basin, San Pedro. (Page 249.) (After Rathbun.)

PLATE 35

Fig. 1. *Cancer anthonyi,* male; dorsal view, × 1½. San Diego Bay, 6 fathoms. ("Albatross" station 3577.) (Page 227.)

Fig. 2. *Cancer gracilis,* male; dorsal view, × 1¼. San Francisco Bay, 10–10¼ fathoms. ("Albatross" station 5802.) (Page 232.)

Fig. 3. *Cancer antennarius,* male; dorsal view, × ¾. Sausalito. (Page 224.)

PLATE 36

Fig. 1. *Cancer amphioetus,* young female; dorsal view, × 1⅕. San Diego Bay, 4½ fathoms. (''Albatross'' station 3591.) (Page 223.)

Fig. 2. *Cancer amphioetus,* male; dorsal view, × 1⅕. Otaru, Japan. (Page 223.)

Fig. 3. *Cancer oregonensis,* male; dorsal view, × 1⅕. Admiralty Inlet, Washington, 26–15 fathoms. (''Albatross'' station 4205.) (Page 234.)

Fig. 4. Same species as fig. 3, female; showing extreme ornamentation of carapace.

Fig. 5. *Cancer jordani,* young male; dorsal view, × 1⅕. Isthmus Harbor, Santa Catalina Island. (Page 228.)

Fig. 6. *Cancer jordani,* male; dorsal view, × 1⅕. Monterey Bay, low tide. (Page 228.)

Fig. 7. *Cancer gibbosulus,* female; dorsal view, × 1⅕. Off Farallon Islands, 33–35 fathoms. (''Albatross'' station 5790.) (Page 226.)

Fig. 8. *Cancer antennarius,* young male; dorsal view, × 1⅕. Venice. (Page 224.)

PLATE 37

Fig. 1. *Lophopanopeus heathii,* female; dorsal view, × 1⅘. Monterey Bay, under stones, mean and low tide marks. (Page 243.)

Fig. 2. *Lophopanopeus lockingtoni,* female holotype; dorsal view, × 1⅘. San Diego Bay, 4½ fathoms. ("Albatross" station 3591.) (Page 244.)

Fig. 3. *Lophopanopeus frontalis,* male; dorsal view, × 1⁹⁄₁₀. Anaheim Bay. (Page 242.)

Fig. 4. *Lophopanopeus bellus,* male; dorsal view, × ⁹⁶⁄₁₀₀. Port Orchard, Washington. (Page 241.)

Fig. 5. *Lophopanopeus diegensis,* male; dorsal view, × 1⅘. Venice. (Page 245.)

Fig. 6. *Lophopanopeus leucomanus,* male; dorsal view, × 1⅘. Isthmus Harbor, Santa Catalina Island. (Page 239.)

Fig. 7. *Cycloxanthops novemdentatus,* female; dorsal view, × 1⅖. Isthmus Harbor, Santa Catalina Island. (Page 239.)

Fig. 8. *Xanthias taylori,* female; dorsal view, × 1⅘. Venice. (Page 246.)

Fig. 9. *Heteractaea lunata,* female; dorsal view, × 1⅓. Panama. (Page 248.)

Fig. 10. *Pilumnus spinohirsutus,* female; dorsal view, × 1½. Santa Catalina Island. (Page 247.)

PLATE 38

(After Rathbun)

Fig. 1. *Pinnotheres concharum*, female; dorsal view, × nearly 9. Off Santa Cruz Island, from ascidian *Phallusia vermiformis*, 30 fathoms. ("Albatross" station 2945.) (Page 252.)

Fig. 2. Same specimen as fig. 1; ventral view.

Fig. 3. *Pinnotheres concharum*, female; dorsal view, × nearly 4. Neah Bay, Washington, surface. (Page 252.)

Fig. 4. Same specimen as fig. 3; ventral view.

Fig. 5. *Ocypode gaudichaudii* male; dorsal view, × ⅘. Panama. (Page 278.)

Fig. 6. Same specimen as fig. 5; ventral view, × 9/10.

PLATE 39

(After Rathbun)

Fig. 1. *Fabia subquadrata,* female; dorsal view, × 1⅔. Pacific Grove, from mantle cavity of edible mussel, *Mytilus edulis.* (Page 253.)

Fig. 2. Same specimen as fig. 1; ventral view.

Fig. 3. *Fabia lowei,* female; dorsal view, × 1⅔. In mantle cavity of boring mussel, *Pholas californica,* Alamitos Bay. (Page 254.)

Fig. 4. Same specimen as fig. 3; ventral view.

Fig. 5. *Fabia canfieldi,* female holotype; dorsal view, × 2⁹⁄₁₀. Monterey, in folds of keyhole limpet, *Lucapina crenulata.* (Page 254.)

Fig. 6. Same specimen as fig. 5; ventral view.

Fig. 7. *Pinnotheres holmesi,* female holotype; dorsal view, × 2⁷⁄₁₀. Pacific Grove? (Page 251.)

Fig. 8. Same specimen as fig. 7; ventral view.

PLATE 40

(After Rathbun)

Fig. 1. *Pinnixa faba,* female; dorsal view, × 1½. From clams at Quarantine Dock, Washington. (Page 259.)

Fig. 2. Same species as fig. 1, male; dorsal view, × 1½.

Fig. 3. Same specimen as fig. 1, female; ventral view.

Fig. 4. Same specimen as fig. 2, male; ventral view.

Fig. 5. *Pinnixa littoralis,* female; dorsal view, × 1½. From clams at Quarantine Dock, Washington. (Page 260.)

Fig. 6. Same species as fig. 5, male; dorsal view, × 1½.

Fig. 7. Same specimen as fig. 5, female; ventral view.

Fig. 8. Same specimen as fig. 6, male; ventral view.

PLATE 41

(After Rathbun)

Pinnixa barnharti

Fig. 1. Male; ventral view, × 2. From cloaca of holothurian, *Molpadia arenicola,* San Diego. (Page 261.)

Fig. 2. Female holotype; dorsal view, × 2. From cloaca of sea-cucumber (holothurian), under pier, Venice. (Page 261.)

Fig. 3. Same specimen as fig. 2; ventral view.

Fig. 4. Male, abdomen, × 6.

PLATE 42

Fig. 1. *Pinnixa franciscana,* male; ventral view, × 3. San Francisco Bay. 7–8½ fathoms. (''Albatross'' station 5825.) (After Rathbun.) (Page 263.)

Fig. 2. Same specimen as fig. 1; dorsal view.

Fig. 3. *Pinnixa franciscana,* female holotype; dorsal view, × 3. San Francisco Bay, 10–12½ fathoms. (''Albatross'' station 5709.) (After Rathbun.) (Page 263.)

Fig. 4. Same specimen as fig. 3, ventral view.

Fig. 5. *Pinnixa occidentalis,* male holotype; dorsal view, together with left chela posed to show outer face, natural size. South of Unimak Island, Alaska. (''Albatross'' station 3216.) (Page 262.)

Fig. 6. Same species as fig. 5, female; dorsal view.

Fig. 7. *Pinnixa schmitti,* male; dorsal view, × 3. Cape Fox, Alaska. (After Rathbun.) (Page 264.)

Fig. 8. *Pinnixa schmitti,* female holotype; dorsal view, × 3. San Francisco Bay, 9½–11 fathoms. (''Albatross'' station 5723.) (After Rathbun.) (Page 264.)

Fig. 9. Same specimen as fig. 8; ventral view.

PLATE 43

(After Rathbun)

Fig. 1. *Pinnixa hiatus,* female; dorsal view, × nearly 4. Off Santa Catalina Island, 50 fathoms. (Page 265.)

Fig. 2. Same specimen as fig. 1; ventral view.

Fig. 3. Same specimen as fig. 1; two legs of left side.

Fig. 4. Same specimen as fig. 1; chela and four legs of right side.

Fig. 5. *Pinnixa tubicola,* female cotype; dorsal view, × nearly 2. From calcareous tube of worm, Trinidad. (Page 265.)

Fig. 6. Same specimen as fig. 5; third leg of right side.

Fig. 7. Same specimen as fig. 5; ventral view.

Fig. 8. *Pinnixa tubicola,* male; dorsal view, × nearly 3. Trinidad. (Page 265.)

Fig. 9. *Pinnixa weymouthi,* male holotype; dorsal view, together with cheliped and two legs of right side, × nearly 4. Monterey Bay. (Page 266.)

Fig. 10. Same specimen as fig. 9; ventral view.

PLATE 44

(After Rathbun)

Fig. 1. *Scleroplax granulata,* male; dorsal view, × 3⅗. San Francisco Bay, 4–7 fathoms. ("Albatross" station 5775.) (Page 267.)

Fig. 2. Same specimen as fig. 1; ventral view.

Fig. 3. *Scleroplax granulata,* female paratype; dorsal view, × 2. Ensenada, Lower California. (Page 267.)

Fig. 4. *Opisthopus transversus,* male; ventral view, × 1⅘. Monterey. (Page 268.)

Fig. 5. Same specimen as fig. 4; dorsal view.

PLATE 45

(After Rathbun)

Pachygrapsus crassipes, male, × 9/10. Pacific Grove. (Page 270.)

Fig. 1. Ventral view.

Fig. 2. Dorsal view.

PLATE 46

(After Rathbun)

Planes minutus, male, × 2. San Benedicto Island, Lower California. (Page 272.)

Fig. 1. Dorsal view.

Fig. 2. Ventral view.

PLATE 47

(After Rathbun)

Hemigrapsus nudus, male, × ¾. Pacific Grove. (Page 273.)

Fig. 1. Anterior view.

Fig. 2. Ventral view.

Fig. 3. Dorsal view.

PLATE 48

(After Rathbun)

Hemigrapsus oregonensis, male, × 1¼. Playa del Rey, Los Angeles County.
(Page 274.)

Fig. 1. Ventral view.
Fig. 2. Dorsal view.
Fig. 3. Anterior view.

PLATE 49

(After Rathbun)

Uca crenulata. (Page 279.)

Fig. 1. Male, antero-dorsal view, × 2. Mangrove Island, Magdalena Bay, Lower California.

Fig. 2. Same specimen as fig. 1; dorsal view.

Fig. 3. Male, outer face of large chela, × 2. Santo Domingo, Lower California.

Fig. 4. Same specimen as fig. 3; inner face.

PLATE 50

(After Rathbun)

Uca musica, male holotype, × 1⅘. Pichilinque Bay, Gulf of California.
(Page 280.)

Fig. 1. Anterior view.
Fig. 2. Antero-dorsal view.
Fig. 3. Dorsal view.
Fig. 4. Ventral view.

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